(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

IX.

THE POWER PLANT.

The electric power plant as a feature of railway shop practice is a product of the last ten years, but there are now a sufficient number of such plants to indicate the general trend of design, and to emphasize those conditions and requirements which are peculiar to the service. Electric power is usually needed for transfer tables, traveling cranes, tools, fans, lighting; in addition to the steam being required as motive power for these purposes, it is also required for air compressors, pumps, hammers and heating; the latter of course only when the supply of exhaust steam is insufficient for the purpose.

The size and capacity of the plant are determined by totalizing the demands for power both internal and external to the building. Beginning with the electric generators, their capacity is ascertained by adding the total fan load and total lighting load, and then a percentage of the total rated capacity of motors used for other purposes; this added percentage may range from 30 to 60 according to whether there are few or many traveling cranes, and the kind and frequency of service they are likely to be called on to perform. To the total so arrived at may be added a percentage to cover distribution losses, growth, and contingencies, this latter percentage of course being largely influenced by local conditions.

Taking the total generator capacity in kilowatts, but expressing it in horse power, it is divided by 0.85 (assumed factor of efficiency for direct connected sets) to determine the necessary equivalent engine horse power, to which is commonly added 25 per cent. in order to have power available for at least a portion of the overload capacity of the generators. Many railway shop power plants hitherto built have provided a very large excess of power over what has actually been required in service; with the experience now accumulated, this is not so likely to recur in the future.

The boiler capacity may be worked out by assuming a rate of steam consumption suitable to the size and type of engine to be used; under present conditions it is probable that the steam consumption per horse power per hour should be taken somewhere between 15 lbs. and 20 lbs. according to the degree of refinement in the engine design. Fifteen lbs. seems far in excess of the 9 lbs. minimum which has been recorded in a few cases in exceptional plants, where triple expansion was used with superheaters and reheaters; but 15 lbs. is a fair minimum for purposes of estimate for every day service under commercial conditions, as compound non-condensing engines are what we now generally find. It is probable that the future has something better in store for us, but we are dealing with present conditions.

Unfortunately boiler horse power and engine horse power are not synonymous terms, as a boiler horse power is simply the capacity to evaporate 30 lbs. of water into steam from temperature 100 (degrees Fahrenheit) to a pressure of 70 lbs. (per square inch,) and this fact has to be borne in mind when estimating boiler capacity corresponding to any given engine capacity. To the boiler horse power thus obtained must be added the necessary excess to furnish steam for hammers and possibly for heating, also to drive air compressors, pumps, or other auxiliaries; the steam consumption rate for auxiliaries will often be two, three, or even four times as great as for the main engines, even under what passes for good practice. The lighting load of a railway shop power plant is usually assumed on the basis of one horse power to each arc light, and one horse power to each ten incandescent lights.

The subdivision of generating units and boiler units can best be accomplished by charting the expected total load through a period of 24 hours, and then so selecting the units as to permit of such combinations as will secure full loads, or as nearly so as possible at all times. Engines and generators are not here assumed to be disabled and unfit for service except in emergencies, but boilers will be out of service periodically for cleaning and repairs, and excess capacity must be provided to cover.

In providing means to drive electric generators we have the opportunity of choosing between the steam engine, the steam turbine, and the gas engine, with increasing thermal efficiency in the series. With conditions as already outlined a unit larger than 750 horse power is seldom required in railway shop power plant practice; this is a little small for best results in steam turbine practice, and a little large for comfort under present conditions of gas engine practice. Steam turbines are actually installed in one plant (Aguas Calientes, Mexico, see page 466, Dec., 1903), while gas engines were contemplated (but not actually used) in a Western plant; meantime current practice has gravitated to the use of compound non-condensing engines, usually horizontal (because floor space is seldom limited), and always automatic, that is, with governor regulated cut off; condensing apparatus is found in one case only, at the West Milwaukee shop of the Chicago, Milwaukee & St. Paul Railway. Gas engine predictions are risky, but a constantly increasing use of the steam turbine may be expected, with condensers as an economical adjunct. When this comes about, power plant buildings can be made of reduced proportions.

Water tube boilers will usually be preferred to fire tube boilers for several reasons: They are much safer to operate (an explosion being limited to a single tube); they take up less space for a given capacity; they are quicker steamers; scale can be removed from interior of tubes by power devices and cheap labor, whereas fire tube boilers must have tubes removed by high priced labor in order to remove scale; and also the boiler will be much longer out of service. These advantages outweigh the greater cost, and the fact that the ratio of water capacity to steaming capacity is small, which means that water tube boilers do not always respond as well as fire tube boilers when there is a sudden and excessive demand for steam; but the net results are in favor of the water tube boiler which is now generally used.

There being several makes of water tube boilers all of high efficiency, the choice will usually be determined by commercial considerations. For a given steam consumption in unit time the water level will fluctuate more rapidly in a vertical than in a horizontal boiler, and the feed regulation will require closer attention; on the other hand a boiler room fitted with vertical boilers will be cooler than one fitted with horizontal boilers, and therefore more comfortable to work in—quite an advantage in hot countries. It is one of the anomalies of power plant practice that the thermal efficiency of steam boilers often approximates to 75 per cent., while that of steam engines seldom exceeds 15 per cent.

Mechanical stokers will be a source of economy in fire room labor in boiler plants of from 1,000 horse power up, and will minimize boiler repairs in a plant of any size, even if considerably less than that; fuel will be used to the best advantage, and smoke reduced to the lowest limit. Feed water heaters are of proved value as a means of rescuing waste heat from exhaust steam, but in winter must usually divide honors with the heating system.

Mechanical draft systems have been perfected so as to be thoroughly practicable and reliable. The fans are usually provided in duplicate and fitted with water cooled bearings; and when the system includes the automatic draft regulator, the amount of draft corresponds to the steam pressure. The whole makes a very flexible arrangement, increases the rate of combustion and evaporation, and reduces the size and cost

of boiler plant required to produce a given horse power; saves first cost, and therefore, interest, insurance and taxes; greatly reduces size and cost of stack; these several savings much more than offset the corresponding items for the mechanical draft plant together with its cost of operation and maintenance, and result in a net saving. Four tests have been recorded where mechanical draft produced boiler horse power (on basis of 34.5 lbs. of water from and at 212°) 55 per cent. in excess of rated capacity; this illustrates the flexibility of the system; the draft produced by a chimney without mechanical auxiliaries is proportional to the square root of its height, which means that the same result produced by natural draft would require a chimney nearly two and a half times as high as the original chimney (provided its diameter was not also increased).

Economizers do not always economize under railway shop conditions, where coal is always cheap as compared with its cost under usual manufacturing conditions, and they are regarded as a refinement a little beyond our immediate needs.

The use of power devices for handling coal and ashes depends largely on local conditions. If a trestle can be arranged alongside the boiler room without interfering with, or sacrificing other yard arrangements, it will usually be found that expensive and complicated apparatus are not warranted, and the very simplest home made mechanical appliances will yield the desired measure of economy; this is true even when mechanical stokers are used, when it of course becomes necessary to elevate the fuel to the level of their hoppers.

The piping of a modern power plant is a critical feature. Boiler pressures have advanced from 80 lbs. to 150 lbs. in the past twenty years, and now all pipes, fittings, pumps and engines are required to stand 200 lbs. Copper pipe has disappeared from practice as treacherous and unsafe material. Steam pipes of to-day are of wrought iron or wrought steel, and often with cast or forged steel flanges, which may be either screwed, riveted or welded on, and sometimes with faced joints. Expansion is taken care of by long bends or by swing joints; the old style slip joints and corrugated copper joints have almost entirely disappeared; the development and introduction of separators, with their receivers or reservoirs, and the gradual introduction of higher pressures, have had their effect in reducing the size of steam pipes, and it is now not unusual to see a steam pipe smaller than the admission pipe to the engine.

The choice of current and wire system for a railway shop power plant, is affected by many considerations, among which are the following: Transmission, whether short distance, or long distance, or both; speed of motors, whether constant, or variable, or both; lighting, whether arc, or incandescent, or both; and whether confined to the immediate locality or extending to outlying and remote points. The relative merits of direct and alternating current for distribution are summarized in table 15, which, however, is susceptible of much further elaboration and refinement.

TABLE 15.

RELATIVE MERITS OF DIRECT AND ALTERNATING CURRENT FOR ELECTRICAL DISTRIBUTION FOR RAILWAY SHOP POWER PLANTS.

Item.	Direct.	Alternating.
Generators	Commutator, with attendant troubles.	No commutator.
Engines	Reciprocating (the speed of generators being limited).	Turbines may be used, as generators can be successfully run at turbine speeds.
Motors	Must have commutators, but may be made to yield variable speed by either of several methods.	Induction type, without commutators, but constant speed.
Lighting (arc and incandescent)	May be accomplished with either current, but direct current is simpler and preferred.	
Conversion (to other kind of current)	By machine (rotary converter or motor generator).	By machine at present, but probably by static apparatus in future.
Transformation (to higher or lower voltage, but same kind of current)	By machine (seldom done).	By static apparatus.
Transmission	Feasible for moderate distances, but (voltage being limited) cost becomes prohibitive for long distances.	Feasible for moderate distances, and the only commercially practicable system for long distances.

The facts that our shop problems are constantly growing larger, that power plants are supplying electrical energy (whether for power or light) for increasing areas, that the steam turbine has great advantages (particularly for high speed work) over the reciprocating engine, and that there is somewhat of a reaction from the excessive use of complex and costly variable speed apparatus, all point to the conclusion that alternating current generating apparatus will be the prevailing practice in large installations in the future, with auxiliary apparatus for converting a portion of the primary alternating current into direct current for those applications where it is to be preferred. The Reading shop power plant of the Philadelphia & Reading Railroad is a notable example, and almost the only one, of the use of both currents with the alternating as the primary; in this plant the rotary converter is of course used, but the development and perfection of the Cooper Hewitt static converter (for transforming alternating current into direct current) may lead up to the complete elimination of the rotary converter.

Although it is believed, as has been intimated above, that variable speed has been somewhat overdone, yet for those cases where it ought to be used, a choice of method must be made. Of all the alternatives it seems that three might be eliminated at once, namely, resistance in the armature circuit (because of wastefulness and inefficiency); the double commutator (on account of cost and complication), and the four wire multivoltage system (also on account of its cost and complication.) This leaves the two wire single voltage system, with adjustable resistance in the field circuit, and the three-wire two-voltage system, combined with field control; and it is

TABLE 16.

ESSENTIAL FEATURES OF RAILWAY SHOP POWER PLANTS.

Place.	Railroad.	Size of Building.—Feet.	Generators.			Engines.		Boilers.	
			Current.	Voltage.	KW.	No.	Total H.P.	No.	Total H.P.
Concord, N. H.	B. & M.	65 x 111	Alt.	440	600	2	400	3	600
Dubois, Pa.	B., R. & P.	63 x 93	Alt. Dir.	220	265	3	300	4	800
Elizabethport, N. J	C. R. R. of N. J.	106 x 107	Dir.	240	300	3	750	4	1,000
Oelwein, Ia.	C. G. W.	42 x 128	Dir.	230	1,000	3	1,050	.	1,200
Bloomington, Ill.	C. & A.	53 x 97	Dir.	220	900	.	1,200	4	1,400
Chicago, Ill.	C. & N. W.	100 x 110	Dir.	220	880	.	1,335	.	1,500
Hannibal, Mo.	C., B. & Q.	60 x 101	Dir.	240	600	3	750	.	1,068
Danville, Ill.	C. & E. I.	89 x 100	Dir.	240	300	2	450	4	1,000
Collinwood. O.	L. S. & M. S.	85 x 130	Dir.	250	875	3	1,425	6	1,800
Jackson, Mich.	M. C.	87 x 92	Alt.	480	460	3	605	3	660
Baring Cross, Ark.	M. P.	77 x 137	Dir.	250	350	3	475	.	1,000
Oak Grove, Pa.	N. Y. C.	100 x 105	Dir.	230	300	2	450	.	500
McKees Rocks, Pa.	P. & L. E.	81 x 102	Dir.	240	600	4	1,000	6	1,500
Reading, Pa.	P. & R.	112 x 175	Alt. Dir.	480	1,750	6	2,250	8	2,000
Ft. Wayne, Ind.	P. R. R.		Alt.	220	900	5	1,275	.	900
Columbus, O.	P. R. R.	81 x 101	Alt.	220	900	3	1,500	4	1,200
Omaha, Neb.	U. P.	80 x 150	Dir.	250	650	2	770	6	1,200
Topeka, Kan.	A., T. & St. F.	57 x 176	Dir.	220	875	4	1,095	6	1,200

believed that future practice in railway shop power plants will be limited to these two systems.

The power plant building being the nerve center of the modern shop, and representing with its contents, an investment of from $75,000.00 to $150,000.00, should be fire proof and isolated, the change from mechanical to electrical transmission having made such isolation practicable. A rectangular building approximating to a square easily subdivides into engine room and boiler room of nearly equal floor area, as required. It generally happens that the floor of the boiler room can be depressed below general ground level to good advantage (where sewerage conditions permit) in connection with handling the coal supply: on the other hand the floor of the engine room can be established several feet above the ground level, with a basement for piping and accessories, such as pumps, heaters, condensers, air reservoirs, etc. In many plants too little head room has been allowed in the engine room basement, which should preferably be roomy, airy and well lighted. In the power plant of the Baring Cross, Ark., shop of the Missouri Pacific Railway, all the auxiliary apparatus has been assembled in what is termed a pump room, which is 16 ft. x 75 ft., open to the roof and interposed between the engine room and the boiler room; this arrangement screens these rather unsightly accessories from the more ship shape and tidy engine room, and also protects the wearing surfaces of pumps, etc., from the dust of the boiler room.

Table 16 embodies the principal data for eighteen shop power plants, and fairly indicates their size and capacity:

Reading, Pa., is seen to be the most extensive plant so far put up. It will be noted also that alternating current is used to some extent in six places. The reason that the kilowatt capacity of generators and the horse power capacity of engines vary so much in plants which, judging from the size of buildings, appear to be intended to provide approximately equal amounts of power, is that the individual opinions of the designers vary so much on the question of what spare units should be provided. There is a noticeable tendency to fully double the voltage when alternating current is used, as compared with that used with the direct current; this is probably due to the fact that, as alternating current induction motors do not have commutators, brushes, slip-rings or collectors, employees have no occasion to handle them, and the risk of shock is therefore minimized.

Switchboard design has become a specialty, in which it is well to let the specialists take the responsibility, and it is a poor place to curtail. The fundamental requirements are, complete isolation of circuits, automatic circuit breakers for overloads, separate panels and recording instruments for each principal circuit, etc.

(To be Continued.)

With the bad waters in the Southwest and under the necessity of providing engines enough for the trains, an effort is being made to extend the life of firebox sheets by removing in every possible way all unnecessary thicknesses of metal between the fire and the water. In this connection crown bolts with large heads are giving place to crown stays resembling stay bolts, having taper threads in the crown sheet and riveted over like stay bolts. On a number of roads opinion favors wider mud rings with 5-in. water spaces at the bottom of the water leg. There is also a tendency toward widening the spaces between tubes, making 1-in. bridges instead of the narrower spaces now prevalent. Several roads are now experimenting in this direction. They are prepared to sacrifice some tube heating surface for the sake of securing more water space around each tube, in the hope of reducing the amount of tube leakage.

STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

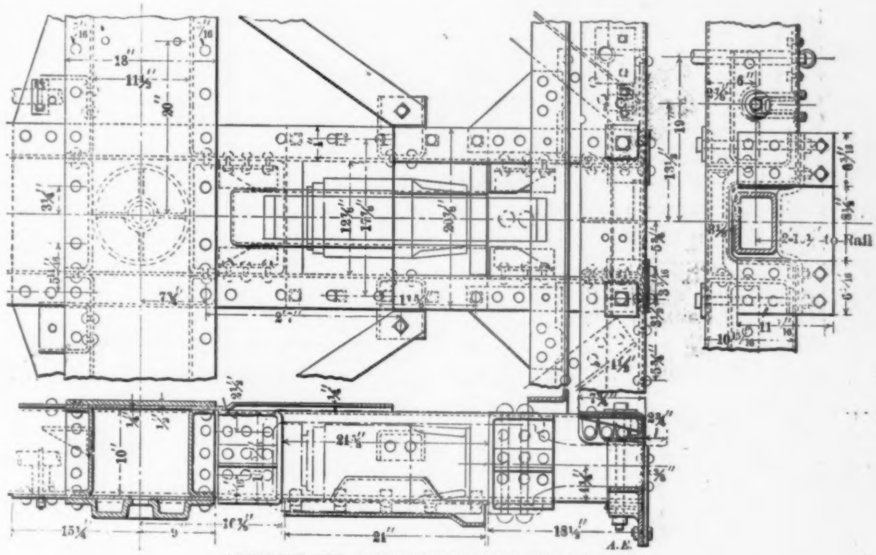
IV.

(For Previous Article, See Page 435, December, 1903.)

BOX AND REFRIGERATOR CARS.

After the appearance of the GL car, which was a double hopper gondola, the next step was the FL design, an 80,000 lb. flat car which was considered as experimental and from which valuable information with respect to the action of pressed steel sills under heavy loads was obtained. It did not become a standard, but was afterward redesigned and adopted under another class which will be referred to later.

At this time, November, 1901, attention was directed toward the box car with steel underframing. After a careful study of the question of capacity and the decision to build large capacity box cars was reached the American Railway Association adopted its standard interior dimensions for 40-ton cars. The fact that this road could handle 110,000 lbs. of grain in box cars settled the question in favor of cars of 100,000 lbs. normal capacity and the standard dimensions of 36 ft. in length, 8 ft. clear height and 8 ft. 6 in. width were adopted, the standard door opening of 6 ft. being also used. Since the underframe was to be of steel the additional cost of making

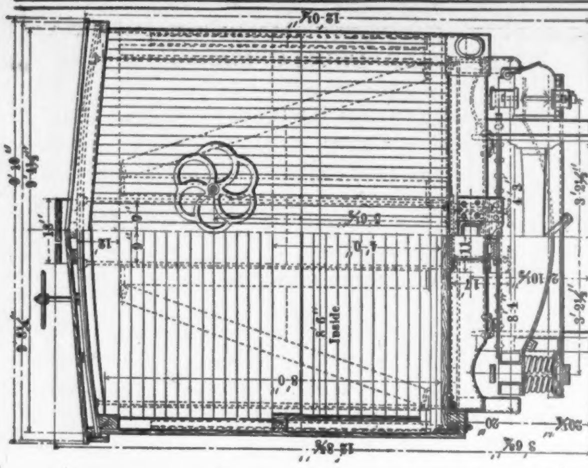


DETAILS OF ATTACHMENT OF DRAFT GEAR.
CLASS XL BOX CARS. — PENNSYLVANIA RAILROAD.

it sufficient for the load of 50 tons was considered as negligible in view of the importance of being able to carry an occasional full load.

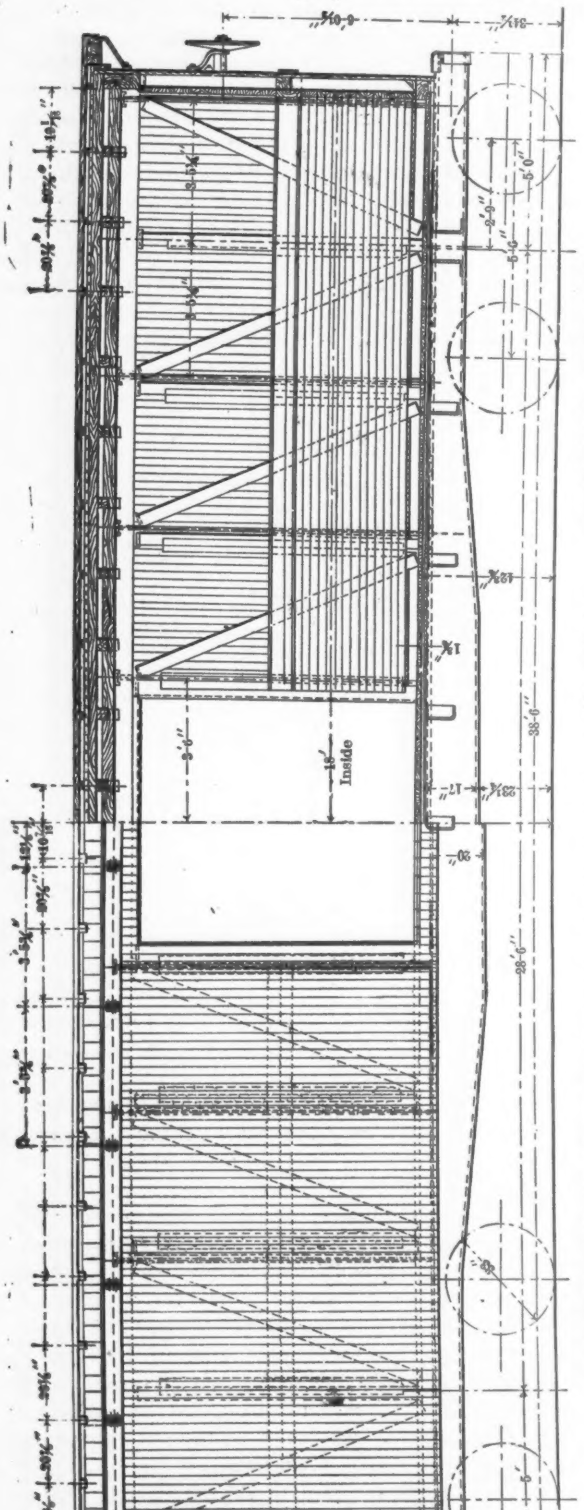
In order to use the standard interior dimensions, a low floor was necessary, and the draft gear was passed through the end sills. The top of the floor is 3 ft. 6¾ in. above the top of the rail and the upper faces of the sills are 3 ft. 4¼in. above the rails. From the excellent and very complete drawings of this car, which is known as the XL design, selections have been made to clearly present the principles of its construction. This is an important design which has led to the introduction of similar construction on a number of large roads. This is essentially a steel underframe car, as distinguished from a car with a steel frame throughout. The box structure is of wood and serves merely to house the load. At this time no attempt was made to embody the frame of the superstructure in the truss structure in actually carrying the load.

While the description is confined to the XL car, the same underframe applies to the refrigerator or RF design. As a backbone, two pressed steel center sills are used. These have 4 in. flanges and are 17 in. deep at the center of the car for a length of 10 ft. At the ends, the sills taper to a depth of 10

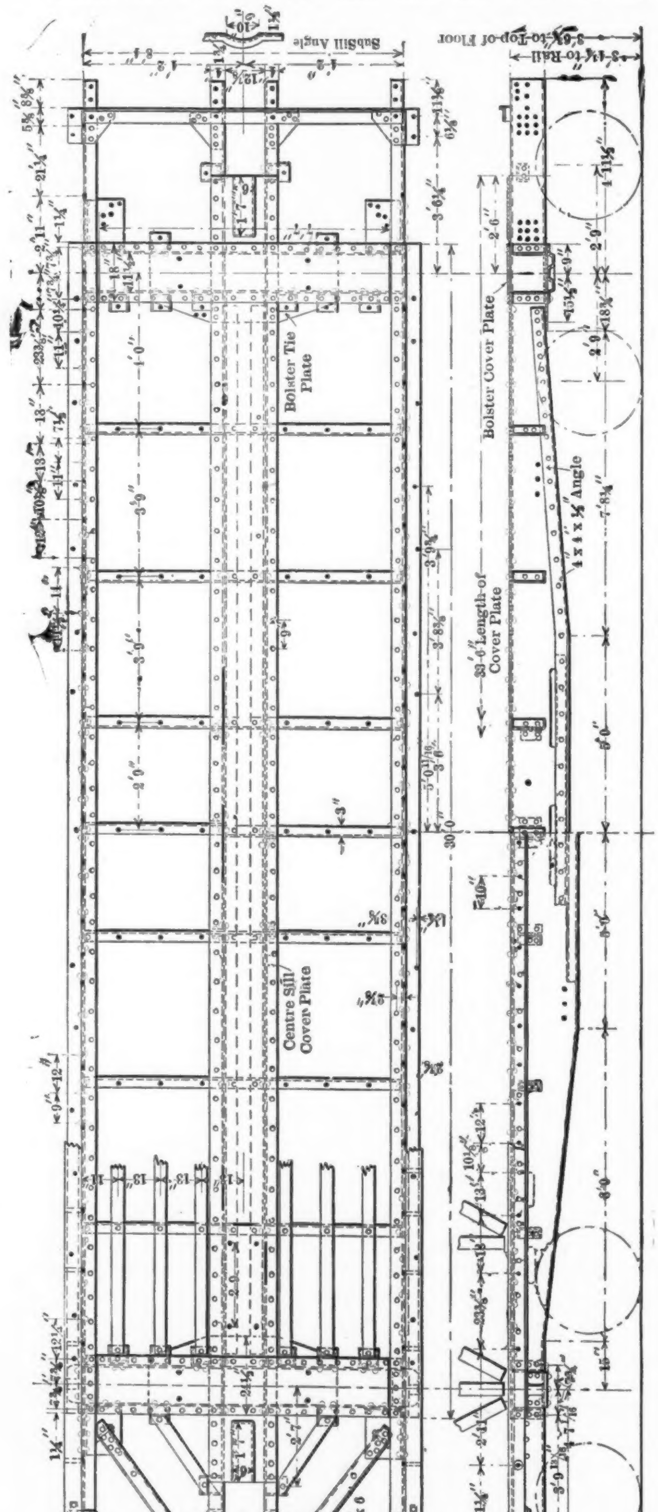


PART CROSS-SECTION AND PART END ELEVATION.

in. The side sills are 20 in. deep at the center. The neutral axis of the center sills is raised by using a cover plate 33 ft. 6 ins. long extending almost the full length of the car (which is the first appearance of this construction) and of the use of 4 by 4 by ½ in. flange angles riveted to the lower part of the webs of the center sills. These angles virtually change the center sills into built-up I beams. With center sills extending the full length of the car the bolsters are necessarily cut. They take the form of pressed trough diaphragms with an 18 in. top cover plate extending across the car. This puts the bolsters into the shape of box girders. The transverse floor supports are pressed steel channels extending between the center and side sills, with short pieces between the center sills. The portions between the center sills are 10 in. deep and those between the center and side sills are 7 in. deep. Upon the latter, the 3 in. wooden floor stringers rest. At the upper

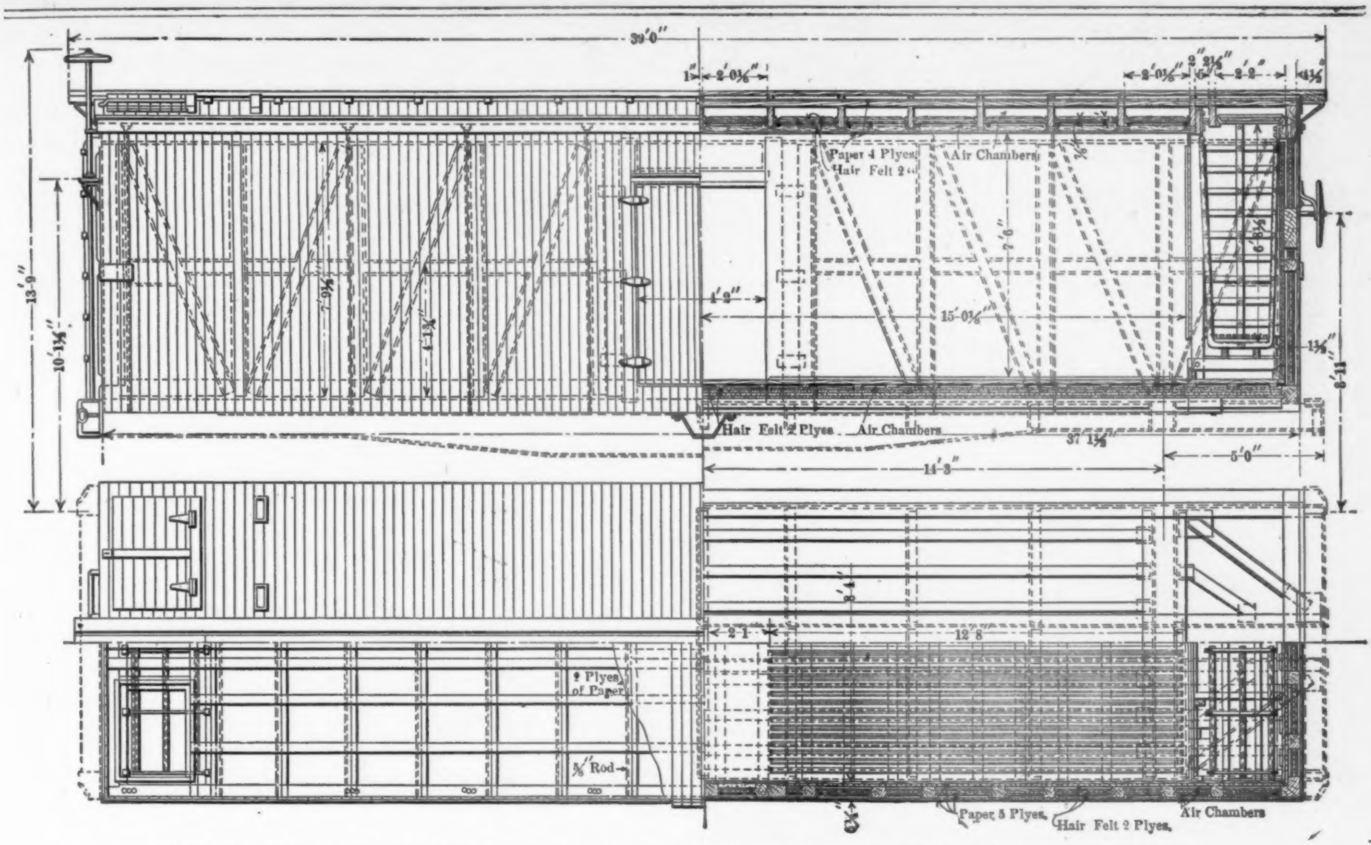


PART SIDE ELEVATION AND PART LONGITUDINAL SECTION OF CLASS XL BOX CAR. — PENNSYLVANIA STEEL CARS.



DETAILS OF THE UNDERFRAMING OF THE CLASS XL BOX CAR.

STEEL CAR DEVELOPMENT.—PENNSYLVANIA RAILROAD.

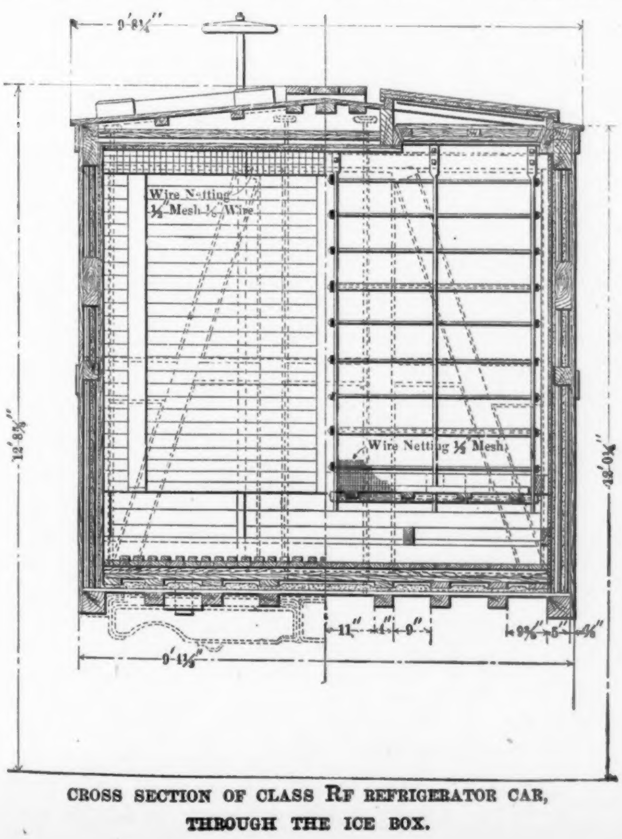


PART SIDE ELEVATION AND PART LONGITUDINAL SECTION, AND PLAN, OF THE CLASS RF REFRIGERATOR CAR.

STEEL CAR DEVELOPMENT. — PENNSYLVANIA RAILROAD.

and outer edges of the side sills Z bars are riveted, and these form the supports for the wooden side structure. This car has corner braces and pressed steel end sills. The draft gear is secured to the center sills, as indicated, and a special pair of diagonal braces serve to support the draft portions of the center sills. The body bolster, draft gear and end sill construction are clearly indicated in the drawing of the draft gear, (see page 3), which is of the Westinghouse type.

The wooden floor rests upon the 4 by 3 in. wooden floor stringers and these are supported on the diaphragms and on pressed steel brackets, at the ends, riveted to the bolsters, as



CROSS SECTION OF CLASS RF REFRIGERATOR CAR, THROUGH THE ICE BOX.

indicated in the plan drawing. The weight of this car, empty, is 45,300 lbs. It is designed for distributed loads. This is the present standard box car of the Pennsylvania Railroad. The design has been modified in some of the details for the Pennsylvania Lines west of Pittsburg. The drawings and this description apply to the standard construction on the Pennsylvania Railroad proper.

The RF, or refrigerator car, has identically the same underframe as the XL car. The upper frames are also similar, except as to end and side plates, intermediate car lines, door posts and belting boards. Of course the floors and walls, also the roofs for the air chambers and the tanks for ice are special features of cars used for provisions and diary products. The great weight of the body of the refrigerator car reduces the nominal capacity to 90,000 lbs. In the drawings, the construction of the superstructure and the insulation are indicated in a way which renders a description in detail unnecessary. Both of these cars are carried on the standard trucks of this road which will be illustrated in another article.

Bad water continues to be the worst problem the Western roads have to deal with. It is now becoming understood that purifying plants are economical, reliable and satisfactory, and they are being installed—but very slowly. The worst result of poor water is not the scaling alone but a combination of scaling and leaking of tubes and seams. This becomes so troublesome that locomotives in some districts need retubing as often as every two months and they require boiler work after every trip over a division of ordinary length. On one road having only a few purifying plants this term of service has already been extended to six months. The requirements which locomotives must meet in the West will necessitate the installation of water purifying plants on a large scale. Water purification has come to stay. It is to be a necessity on all roads having bad waters and it is highly important to install the apparatus with a view of low cost of operation and absolute reliability. First cost is a mountain to most managers and several are experimenting with "cheap" devices. One thing is now demonstrated—water purification is appreciated as an operating necessity.

EDITORIAL CORRESPONDENCE.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

(LONDON, DECEMBER 5, 1903.)

In forming judgment upon the practice of a foreign country in transportation methods it is necessary to look rather deeply into the principles for superficial indications may not be understood. While the equipment and its operation seems strange to an American, nothing is done here without a reason. Nothing is slipshod here and it is generally easy to trace the causes for the practices which appear to be strange. One of the characteristics of English people is conservatism. It must be remembered that these islands were densely populated when the railroads first came up for consideration. Large estates and busy cities were conceived in the location of the roads. Much opposition was met from the very first and it became necessary to satisfy demands for the public safety which we have never known and which we are only now beginning to appreciate. This led to construction of such heavy and permanent character, with respect to the roadbed, terminals and overhead bridges, as to influence the entire development of the roads in other respects. The rolling stock is affected by this to a great extent and also by the fact that it is a logical descendent of the stage coach. We must remember that we took our rolling stock "ready made" and could begin with a clean sheet. The result is that Europe has built thoroughly upon lines which are now found to be too narrow. Among the progressive English railroad men the large train unit and small dead weight of our freight equipment are greatly desired, but they cannot increase the length of sidings, or enlarge the cross section of their numerous tunnels. They have, however, devoted themselves to economical operation with respect to locomotives in a way which is worthy of most careful study.

European permanent construction is both a blessing and the opposite, in its effects upon practice and progress. As our railroads preceeded the people, and our rails went West in advance of the population we know nothing about this, except in the case of a few large terminals. When so much money is put into English roadway and terminals, when so much is spent to avoid curves and grades and so much sunk in tunnels, it becomes most important to see far into the future, in order to provide for growth and improvement. Our own roads are approaching the important problems of permanent construction. We need to look further into the future than the foreign roads have done or we shall be handicapped as they are with structures, which are too expensive to tear down and are yet too small for growth. This strikes the writer as being an exceedingly important lesson. That part of permanent construction, however, which permits of the statement that there is no grade crossing of two railways in Great Britain is to be most emphatically commended.

Human life is held in high regard in Europe and specially this impresses one in England. Grade crossings with streets are entirely absent and every possible precaution is taken to guard against accidents. At stations, even at small ones, passengers pass from one side of the roadway to the other by subways or overhead bridges and this applies to outlying stations where little business is done, as well as to the larger and even most important ones. The writer came very near getting into trouble on a well known English road because he wandered off into the yard while waiting for a train. It was very pleasant to meet shunters (corresponding to our switching crews) who politely touch the cap in answering a question. It is rather impressive to be firmly, but politely and promptly ejected from the yard by the station police.

No trespassing is allowed on tracks here. The people are brought up to respect authority and they do so. The police of London do not carry arms or clubs, yet they conduct the street traffic so well as to bring the number of fatalities in the city streets for last year down to 158, against 538 for the same time in New York City. This shows a difference which explains the small number of accidents here. The people do not do as they like, but as they are told. Good discipline obtains with the public as well as with railroad train and engine men.

English signaling is a revelation even to one who reads and thinks he knows all about it. These railroads have very small wreck accounts. They pay dearly for an injured passenger and prefer to put their money into preventives. When an engineer comes to a signal in the "on" position he stops, for it means something. It means that if he passes it when he should not, he loses his job. Therefore a stop signal means "stop." These men learn to respect signals, because they have them, not as we have them—for perhaps a few miles of road and none on the rest of it, but they run by them all the way. They are not expected to take any chances as to collisions, but to obey the signals, and they certainly do it. Furthermore, English signals are beautifully placed. They are most carefully "sighted," and there is not the slightest indication of efforts to save money at the expense of perfect signaling. In this matter our railroads suffer severely in comparison. It is true that English block signaling is unnecessarily expensive, and this may be due to the cheap labor, but its completeness and the skill applied in its installation is gratifying. The same results would be possible with automatic signals—if we had the discipline of English roads with respect to this branch of the service. As an English gentleman who has spent a long time in the United States puts it—"In England we have signals all the way. We do not run as you do, 40 miles by signals and the next 1,000 miles by instinct and judgment." The Board of Trade sees to it that a piece of road is properly signaled before it can be put into service.

No better idea of the difference in operating conditions between England and the United States can be given than by comparing freight business in the two countries. In England the "goods" traffic seems very much like our express business. This influences the entire business of English railways. Mr. Edwin A. Pratt says: "At the Great Northern meeting (February, 1903) Lord Allerton presented a statement showing the results of a day's work at one of the freight stations on that line, the figure being as follows:—Total number of consignments, 985; total number of packets, 4,427; total weight, 123 tons, 2 cwt.; average weight per consignment, 2 cwt.; average weight per package, 62 lbs.; total number of trucks used, 53; average load per truck, 34 cwt.

As representing the other extreme the contract taken by a Western road in the United States should be mentioned, namely, that for hauling 6,000,000 tons of ore over a certain section of road in 180 days. In Europe there is nothing like this and it seems impossible to handle business on such a scale over here. Our heavy freight work is entirely unknown here and the conditions of operation are absolutely different. English roads are far ahead of us in small dead weight of passenger cars per passenger carried and we are far ahead of them in handling freight. They, however, do not have our conditions and our large quantities of freight to deal with. Our ore, coal and grain business would swamp English roads. English methods are developed on widely different lines, those of small packages, rapid transit and immediate delivery.

An official of Sir Thomas Lipton's company told the writer that most of their patrons in the United Kingdom keep comparatively little stock on hand, but depend upon the quick delivery of the railroads to keep them supplied. A dealer in Manchester often telegraphs in the afternoon for some needed supplies. They are "fetched" from the Lipton stores by a railroad delivery wagon in time for a 6 p. m. train and go by passenger train, to be delivered by the railroad delivery wagon system before 9 a. m. the next day in Manchester. This is a distance of 183 miles and the service is equivalent to our express business. When sent by goods trains, however, delivery within 24 hours is customary at such distances. This rapid service and the small parcels of freight throw a strong side light upon methods of handling freight traffic in England. This explains the small car and the very light load per wheel.

These small cars are almost amusing. They are scarcely

larger than wheel barrows and it is incomprehensible that they should be seriously considered as a limit to the capacity of freight equipment. As a rule they have only hand brakes and here is where the foreign railroad is lame. These trains, light as they are, break in two and the cars pile up over the opposite track. There is nothing to prevent breaking in two, except the screw threads on the couplings in the use of passenger equipment and light chains on the freight cars. In the absence of automatic brakes freight cars are bound to pile up if the train breaks in two. In couplers and brakes we can congratulate ourselves in being years and even generations ahead of our foreign friends. It is necessary to see conditions on this side of the water, in order to fully appreciate what our Master Car Builder's Association has accomplished in the matter of couplers and also in brakes. A series of brake trials here, such as the Burlington tests of that association, would revolutionize English practice. Some of the "joint stock" used on the lines from London to Scotland is equipped with both the Westinghouse and vacuum systems. Imagine the complications of brake gear under one of these small cars having both systems. Even the perfection of signaling cannot indefinitely postpone a serious lesson in braking of freight "trucks" and in the proper braking of passenger equipment. When the need is once appreciated the remedy will probably be applied with characteristic thoroughness. A fair view of the present brake and coupler situation here must be a very unfavorable one. If it were not for the fact that a grade of 1 in 40, three miles in length, is considered a heavy pull in England this would have been fixed long ago.

The English locomotive superintendents are busy men with large responsibilities, yet they seem to have time for all they have to do and are generally very comfortable. "The English do not live for the sake of working, but work for the sake of living." They work hard but are not devotees of the "strenuous life" to the exclusion of proper amounts of rest and pleasure. They are as a rule inaccessible before eleven o'clock in the morning and it is necessary to arrange appointments in advance in order to be sure of seeing them. The writer has been everywhere very cordially received and has been impressed in the case of every one of these officers whom he has met, with the fact that they are big men, keen students, careful thinkers and responsible railroad officials. They all talk as if the entire responsibility of their departments rested entirely upon them, and as a matter of fact it does. In a large sense, they have autocratic powers and as a rule, while subordinate to their general managers, they deal with the directors themselves, and thus play an important part in the policy of the railroad; usually the large motive power questions are dealt with by a committee of the directors, who hold fortnightly meetings, with the highest official of the road, the chairman presiding. The general manager of the road may or may not attend. I am told that he usually does not, unless questions of operation are involved. This brings the motive power department into a prominence which it has not attained with us. In fact, it seems that English stockholders look upon this as the most important department and the one from which most is expected. The officer in charge of it is therefore much in the public eye and is high in the councils of railroad men. Occasionally a motive power officer is selected for the head of the operating department, but, as a rule, he is content to spend his life in his special line of work, because it is made worth his while to do so. Retirement comes usually at the age of 60, and after arriving at that attainment the locomotive superintendent may be requested by the directors to retain his position. Some have thus been requested to remain for ten additional years. These officers seldom leave railroad service for any other work, simply because they are appreciated and are able to do better in it than they can elsewhere. They occupy high social positions and this means much in England. Their opinions are respected. They are encouraged to build up most excellent discipline and to consider safety first, celerity second and economy third, in the order of their efforts. There is much in this which should be seriously considered in the United States, where the situation with respect to motive power officials is not what it should be. It is very rare in England for a road to take a high motive power officer from another road. In fact, this is almost unheard of. How is it with us? Salaries here are higher than on our railroads; that is, those of the locomotive superintendents; and a works manager finds it well worth his while to wait for his turn.

In England there seems to be no connection whatever between the condition of locomotive and car equipment and the stock market. The authority of the locomotive superintendent seems to be far beyond the reach of the stockholders when questions of safety and proper working condition of equipment are concerned. No president or general manager here buys locomotives or cars without consulting the head of the mechanical department. He would not dare take such responsibility.

American railroads might wisely place superintendents of motive power upon the basis of the unlimited authority of the English mechanical superintendents, combined with the unlimited responsibility of the American general managers.

The locomotive superintendent's position here carries with its authority a danger in the temptation to follow fads in mechanical matters. Most of them are too broad-minded to go very deep, but the differences in the practice of roads in the same territory is frequently very marked. The greatest differences in locomotive practice are seen on parallel and even on connecting lines using joint passenger "carriages." Furthermore, the jealousy among the mechanical officers is quite an expensive luxury which an organization like our Master Mechanics' Association would very quickly overcome.

It is the opinion of the writer that the money saved by improved fuel economy of locomotives is lost over and over again in other ways. In the operation of light trains, in the shops and in the lack of labor-saving appliances.

Our Master Mechanics' and Master Car Builders' associations are held in high esteem among English mechanical railroad men. They are even looked up to in admiration because of their influence in improving practice and extending the tendency toward uniformity. There is nothing of this kind here and there is no centralized authority or concerted effort to accomplish anything whatever for the good of the railroads as a whole. The rule is for each superintendent of motive power to individualize his efforts and stamp his practice with his personal views and opinions. Almost all of the mechanical men have carried this to the point of reflecting their own personalties in their practice. The successful use of an important principle on one road, instead of being an example for others to follow, is exactly the opposite, and is practically a thing which the others consider something for them not to do. For example, the writer was told that one road adopted and successfully used track tanks and water scoops, obtaining great advantages in light tenders and long runs, for twenty-five years before the example was followed by other lines.

In England, however, the government controls many matters of construction and operation through the "Board of Trade." By its power—which is far greater than that of our Interstate Commerce Commission—its influence is in a sense restrictive, and it does not always tend toward smooth and unfettered operation, but it is a centralized authority, and it seems likely to act a very prominent and important part in such matters as have been standardized in the United States by the American Railway Association and the mechanical associations. English roads need a Master Car Builders' Association, but in its absence the Board of Trade may, by asserting itself, effect the results which have been accomplished by American railroads by voluntary co-operation in these associations. English railroad men regard with wonder the adoption of a standard coupler contour. They cannot "get together" on anything, whether of that or any other form, and we should therefore not fail to appreciate the achievement of the Master Car Builders' Association in this great work. It is far better to voluntarily agree than to be compelled by government authority to adopt an improvement, because of the failure to come to such agreement! G. M. B.

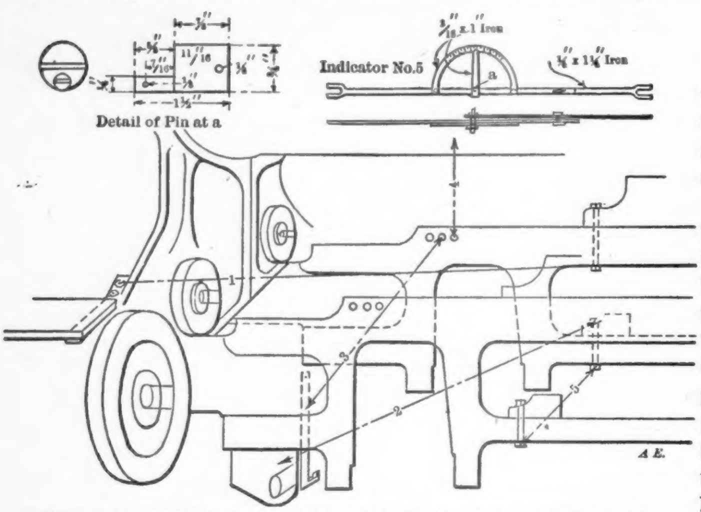
(To be Continued.)

LOCOMOTIVE FRAME DEFLECTIONS.

UNDER SERVICE CONDITIONS.

During the past few years locomotive frame breakages have become very troublesome. On some roads the difficulty has caused great anxiety. It seems to be prevalent with all of the heavier types of engines and is not confined to this country alone. It is argued that vertical deformation or deflection cannot be avoided and that if the structure is made rigid against such deflections the only relief is in fracture. Another opinion is that the lateral movements cause the breakage, as it has also occurred in engines which are flexible at each end, such as the 2-6-2 and 4-4-2 types. Another theory has just been developed with the support of experimental evidence.

The consolidation locomotive of the Lake Shore & Michigan



SKETCH OF INDICATORS USED TO MEASURE LOCOMOTIVE-FRAME DEFLECTIONS IN SERVICE.

Southern Railway (AMERICAN ENGINEER, February, 1900, page 37) recently developed many frame breakages, the defect occurring almost always on the right-hand side and generally in the top bar over the leading driving axle. In an attempt to discover the causes some experiments were made to ascertain the extent of the movements of the frames in service on the road, it being reasonable to suppose that the movements in the frames would indicate the stresses to which they were subjected.

Metallic indicators were applied to one of these engines so made as to multiply the movements of the points of attachment in the ratio of 1 to 24, the pointers being read from a scale attached to the indicator. Mr. G. H. Case, special apprentice, who carried on the experiments, rode on a seat placed over the front axle, in a position from which the movements of the pointers could be watched and recorded. The perspective sketch shows the locations of the five indicators. Rod No. 1 connected the cylinder saddle, on the left side, with the top of the right-hand frame back of the first pedestal. No. 2 connected the bottom of the left-hand frame in front of the first pedestal with the bottom of the right-hand frame back of the first pedestal. No. 3 connected the bottom of the left-hand frame with the top of the right-hand frame in front of the first pedestal. No. 4 connected the top of the right-hand frame with the boiler and No. 5 ran between the bottom sides of the frames just back of the first pedestal.

With these indicators attached, runs were made with the engine in actual service, never pulling less than 40 loaded cars. Indicator No. 1 was 6 ft. 10 in. long and showed a motion of 1-32 in. The vibrations occurred with every revolution and were little affected by roughness in the track. No. 2 was 5 ft. 4 in. long and revealed a maximum deflection of 3-64 in. The vibrations were noted at every revolution and also were affected by the roughness of the track, the latter producing the greatest deflections. No. 3 was 3 ft. 8 ins. long and showed practically no deflection. No. 4, 3 ft. 4 in. long, showed 1-32 in. rise of the frame corresponding to each revolution and was influenced by roughness of the track and rolling of the engine. No. 5, length 3 ft. 7 in., showed a movement of 3-64 in. of the frames with reference to each other. The minimum vibrations occurred when the engine was running smoothly and they corresponded with the revolutions of the drivers. The maximum occurred when the drivers slipped and at rough spots in the track.

In the test the engine was in good condition, being but recently out of the shop. The tests were made on the Lake Shore road where the track was in good condition. In order to determine the effect of rough track and an engine not in the best condition the tests were carried out on another engine of the same class on the Franklin division with the following results:

Indicator.	Movement.
No. 1	3/32 in.
No. 2	1/8 in.
No. 3	Very slight.
No. 4	Very slight.
No. 5	3/32 in.

The motions of Nos. 1 and 2 were in unison and occurred with each revolution. No. 5 was affected most by the rough track and the blows of the flanges of the wheels upon the rails. The severest vibrations were found in working the engine down grade at high speed, and also on up grades.

These tests show that there is a lateral movement of the tops of the frames back of the pedestals, but that there is very little vertical movement between the frames and the boiler. There is also an inward movement of the lower jaw and this would appear to indicate that the movement is largely induced by the lateral forces imparted to the frames from the driving wheels. In engines, as usually braced, there is nothing to prevent the lower bars from swinging sidewise together. As a result of these tests it has been decided to provide for this on future engines, as it is possible that the twisting shown in these experiments, which is not provided for at present, may have considerable influence upon the frame breakages. The movements of the frames also indicate that the leading drivers exert a considerably greater guiding force than is advisable. This is probably due to insufficient initial lateral resistance on the truck used, which was the single point suspension type. This is to be overcome by the use of three-point hangers, having pivots at 3½-in. centers, and swinging links 12 ins. long, which will increase the amount of guiding done by the truck and reduce the stresses on the drivers to a considerable extent, especially when it is considered that the drivers are very close to the center of gravity (or, more correctly, the center of oscillation), whereas the truck is much farther away and consequently acts with more favorable leverage.

We are indebted to Mr. H. F. Ball and Mr. H. H. Vaughan for this information.

STANDARDIZING MACHINE TOOL PARTS.

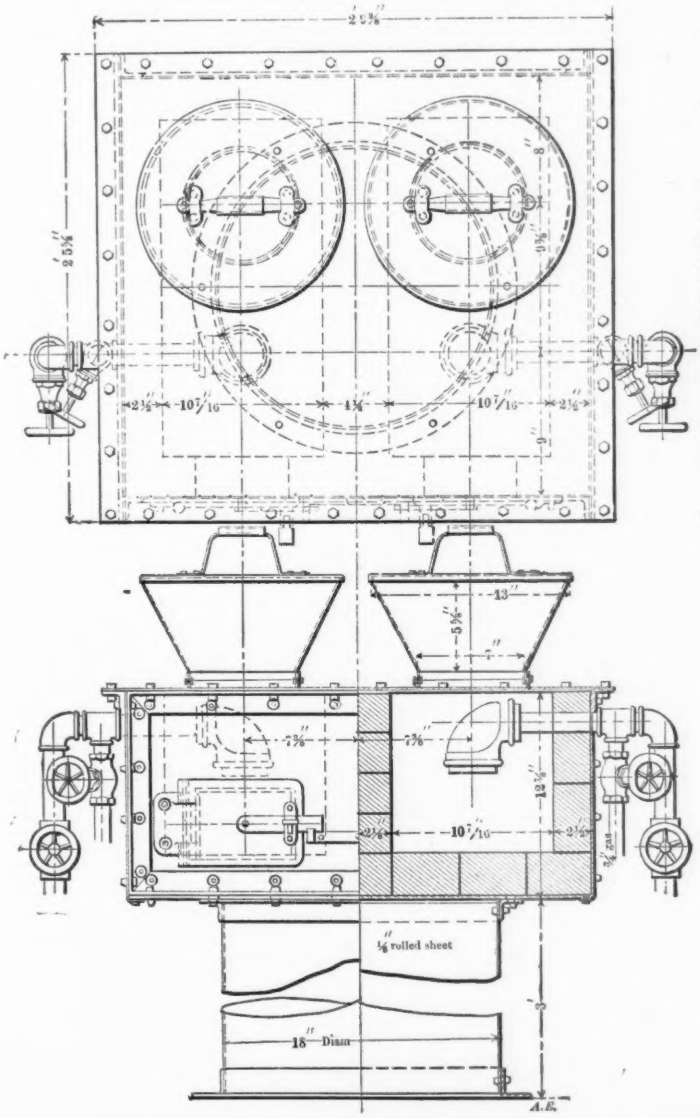
Mr. William Lodge, in his paper recently read before the November meeting of the National Machine Tool Builders' Association in New York, suggested the advisibility and the advantages to the association, if it could possibly be brought about, that some standard be adopted. He questioned why all manufacturers of machine tools might not have the same size of general bearings, the same size of nose for the lathe spindles for the different sizes of lathes, so that customers may find it easy to transfer faceplates, chucks, and tools from one machine to another, irrespective of who may have been the manufacturer. This would be a most important matter, not only to the builders, but to the customers, and it would, at least, have the effect in foreign countries of securing preference for American tools, because of their interchangeability at certain points and because of their uniformity in weight and power. He did not advocate uniformity in the design of the machines throughout, and referred to the utter impossibility to secure uniformity in the quality of the work put into the machines, but he thinks it will be of great assistance to incorporate the features mentioned wherever possible.

GASOLINE GAS RIVET FURNACE.

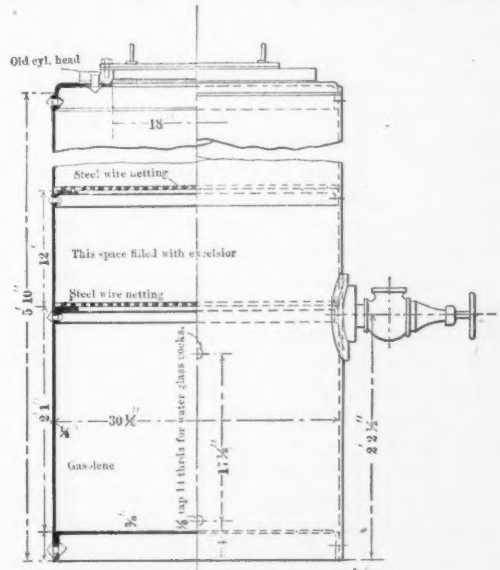
CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.

For use in connection with the hydraulic riveter in the boiler shop of this road at St. Paul, Mr. R. B. Moore, mechanical engineer, has gotten up an effective and convenient rivet furnace. It is heated by gas generated from gasoline in a tank placed outside of the building. The tank was made from the cylindrical portion of an old pump boiler and holds about a barrel of gasoline. Between the gasoline and the filter is a space for the gas, which passes upward through the nettings and filter of excelsior before passing to the furnace. Air is supplied through a 1-in. pipe to the bottom of the tank at a pressure of 5 lbs. per square inch. A 1¼-in. relief valve guards against excessive pressure. A 1¼-in. pipe leads the gas to the furnace, which has two compartments and two burners. Low-pressure air is brought to the burners through a 1-in. pipe. The burners are simply perforated plates, screwed into the fittings shown in the engraving.

The forge is made with two compartments in order to heat



DETAILS OF THE FURNACE FOR HEATING RIVETS.



DETAILS OF THE GAS GENERATOR.

A NEW GASOLINE-GAS RIVET FURNACE.—CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.

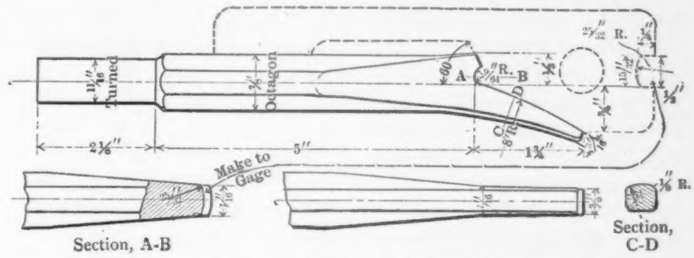
two sizes of rivets at the same time. They may be heated faster than they can be used. Rivets are put into the top of the forge and they bank up at the back end, where they are kept warm, so that but a short time is required to heat them ready for use. It is stated that they are not liable to burn. This forge is located on a platform which has a sliding portion on each side of the riveter jaws, so that the operators need not lean out or use long bars. This sliding portion of the platform is operated by a wheel at the side. This arrangement saves labor and is very convenient for the workmen. We are indebted to Mr. Moore for the drawings.

STANDARD BEADING TOOL AND GAUGE.

NEW YORK CENTRAL RAILROAD.

In order to secure good flue work in locomotive boilers it is necessary to give close attention to the beading tools. In discussing this subject before the Master Mechanics' Association last June, Mr. R. H. Soule said of his experience on the Norfolk and Western.

"It had been suggested that the beading tools used over the road in different roundhouses were not uniform as regards



THE NEW STANDARD BEADING TOOL AND GAUGE.—NEW YORK CENTRAL RAILROAD.

the contour of the curve on the shoulder. Samples of these tools were sent to Roanoke and compared. It was a curious object lesson. They found the most battered-up lot of tools you ever saw; there was no uniformity in them. Some would give flat beads and some circular beads, and there were all the intermediate forms. The conclusion was that what was needed was to establish a standard contour line for the edge of the horn on the beading tool; to provide the necessary number of templates, distribute them over the road, and require that the shoulders should all be ground to these templates."

This has been done on the New York Central, the practice dating from about a year ago. In the accompanying engraving the standard beading tool of this road is illustrated, and in dotted lines the outline of the template is indicated. This template supplies a standard gauge for the angle of the heel, and the curved face of the tool must fit a radius of 9-64 in., as well as follow the established contour which is cut in the end of the gauge, as seen in this engraving at the right.

These gauges are issued to the various shops and the tools are required to be kept in condition to fit them.

RAILROAD SHOP MANAGEMENT.

By William S. Cozad, Norfolk & Western Railway.

II.

Having referred, in the first article of this series, to the harmony and good will which always exists in every well organized shop, and offered some suggestions as to how this end may be attained, it will be the purpose of this paper to examine some of the underlying principles upon which must rest the adoption of such piece-rates as will insure a largely increased output of the shop and also increase the earnings and better the condition of the workmen. The foundation upon which must rest any successful piecework structure is this: that no railroad company or corporation is justified in demanding of its employees an increase in the amount of work turned out, without offering a corresponding increase in the earnings for the extra effort required. It is, in almost every instance, a comparatively easy matter to calculate the capacity of a machine, but long experience has proven that the capacity of men is a variable quantity, and, on a very large part of repair work, much skill would be required to determine the amount of labor which should be performed in any given time. To insure satisfactory results in this respect, the first step which should be taken by the management of any railroad contemplating the introduction of piece-rates is to place the entire problem of rate fixing in the hands of a competent, trained, piece-work expert, who will make a careful study of local conditions, proper organization, pass on each individual price, before it is put into effect, cut out all obselete practices, require strict adherence to all scheduled rates, study methods of increasing output and decreasing cost, and place himself in such close relation to both foremen and men as to make them feel perfectly free to appeal to him in any difference of opinion that may arise in fixing prices. Following this must come absolute and unqualified support of the piece-work principle from the management, and no railroad of any consequence should attempt this work until these preliminaries can be carried out.

It is said there is a standing advertisement all over this country for the man that can do the thing that nobody else can do, or that can do a thing in a way that nobody else can do it—the man that is always looking out for new ideas, improved methods and up-to-date ways of doing things; and without wishing to in any way magnify the responsibility attached to such a position, I believe that road which employs the man who comes nearest the above standard will not only make rapid progress in the introduction of piece-work, but will in the end find that a set of rates have been established which are eminently satisfactory, both to the men and the management.

Occasionally it is argued by men of note in railroad circles that the adoption of piece-work prices that will be fair to the men and the company is largely a matter of guesswork; that adjustments on account of mistakes in fixing original rates are often necessary. From whence come these impressions? Would any competent man be willing to admit that after going into a shop and studying the conditions covering a single item, he could not make a fair and equitable price? And if this can be done on one item, why not on another, and another? Piece-work is a matter of the systematic study of individual operations and as an illustration of the source from which these mistaken ideas are derived let me cite one or two cases. In two different blacksmith shops, the conditions in both of which are perfectly familiar to me, common freight draw-bar follower plates are made as follows:

Shop No. 1.	Shop No. 2.
1. Bar iron brought into shop, cut to length and put into high class oil furnace.	1. Bar iron delivered to shears.
2. Plates heated, taken from furnace, put on bulldozer, 2-in. hole punched through to within ¼-in. leaving dowel on opposite side of plate, and loaded on truck.	2. Plates cut to length and 1⅛-in. hole punched.
3. Plates delivered to storehouse.	3. Plates delivered to smith on open fire.
	4. Round bar iron, 1⅛-in. diameter, delivered to shears.
	5. Iron cut into 6-ft. lengths.
	6. Iron delivered to upsetting machine.
	7. Dowels upset to 2 ins. and cut off.
	8. Dowels delivered to blacksmith.
	9. Dowels heated in ordinary open fire, two or three at a time, put into plate and riveted over on anvil with hammer and sledge.
	10. Plates delivered to storehouse. (The above number of operations are shown because they are either performed by different men or by the same men at different times.)

This is a piece-work job in both shops. In shop No. 1 the work was divided into the elements best suiting the conditions and prices fixed after careful study of the time required to do the work; while in the other case they conform exactly to the guesswork idea mentioned above. In shop No. 1 the rates will remain satisfactory. In shop No. 2 methods and prices are unsatisfactory, both to the men and the management, and will have to be changed.

In the same shops the method of making freight car brake levers is as follows:

Shop No. 1.	Shop No. 2.
1. Bar iron brought in, levers cut off and put into first class oil furnace.	1. Bar iron delivered to shears.
2. Levers heated, drawn out under power hammer, cut to length and loaded on truck.	2. Levers cut off.
3. Levers delivered to drill press in machine shop.	3. Levers put into coke fired furnace.
	4. Levers heated and drawn out under power hammer.
	5. Levers delivered back to shears.
	6. Levers cut to exact length.
	7. Levers loaded on truck and delivered to drill press in machine shop.

In fixing prices on work, such as described above, the following elements, which are not mentioned in these comparisons, must be considered: The location of the iron with reference to the shears; the condition and speed of the shears and punch; the class and condition of furnace; the kind and condition of hammer. With work of this class outlined as indicated above and the time element for each operation carefully considered, no excuse should be accepted for a mistake in fixing an equitable piece-rate.

In the machine department, upon which rests the output of about seventy-five per cent. of the railway repair shops of the country, we have to deal almost exclusively with the capacity of the tools in use, the quality of material used in repairs being a matter of secondary importance. In many cases a large part of the tools are emanations of the forgotten past, nobody remembering when they were put into the shop or where they came from. Usually any request for better facilities is worse than futile, because to the ordinary stockholder all machines look alike as a means of declaring a dividend. The only alternative, then, is to improve on past records. To do this special attention must be given each individual machine to see that it is in the best possible condition. If it is a driving wheel lathe that has been in constant service twenty-five or thirty years, it will, no doubt, need a little touching up in the way of new feed screws, tool post heads planed off and covered with quarter inch plates of rasp-shaped, hardened steel to prevent tools from slipping, new studs and nuts, countershaft put in perfect alignment, machine drawn down to foundation, all boxes closed and bearings examined, and most important of all, a new double belt as wide as the cone will take. A double belt is one of the greatest improvements that can be applied to an old machine. It is a never-failing remedy for the man who has a special tenderness for his lathe, because it at once refutes his argument that the machine will not carry a heavier feed or cut.

As an illustration of the point I wish to make, we have in one of the shops on the road, with which I am connected, a driving wheel lathe which has been in constant service more than

thirty years. A short time ago this machine was overhauled about as detailed above and at present the average time required to turn a pair of driving wheel tires on this lathe is from four to five hours. To be exact, this machine is turning the tires on twelve pair of driving wheels every six days.

An inspection of every tool in the shop, from the smallest drill press to the large frame planer, must be made and all necessary repairs attended to before rates can be properly established. With the machine in good condition, the amount of feed and speed will depend largely on the grade of the tool steel and the shape of the tool used for any particular work.

It is not the purpose of this article to examine into the details of feeds and speeds, but it may be remarked that recent tests have demonstrated very clearly that on medium steel a speed of 35 to 45 feet per minute, with a feed of 10 turns to the inch and a 3-16 in. cut, can be maintained. On wrought iron free from slag, 50 to 60 ft. per min. may be maintained; on cast iron about 40 ft. per min.

In the ideal scheme of production, antiquated cutting tools, slow speeds and fine, hair-splitting feeds can have no part whatever. With machines in good condition, tools that will remove the maximum amount of material in a given time with the least frictional resistance and retain their cutting edge, form a necessary part of a perfect combination. The man who runs his machine, instead of letting his machine run him, will soon discover the proper shape of tool for a given operation, and on all forgings that have been roughed out, the amount of feed and depth of cut will then be limited only by the pulling power of the belt.

For every operation there is a best form of tool, (not a half dozen different shapes, one as good as another), and as many of the operations in a repair shop are repeated every day, too much care cannot be exercised in determining that shape. Having adopted a series of standard sizes and shapes, tools should then be forged in dies to within 1-16 in. of actual size and delivered to the grinding room.

Whenever a machinist is kept waiting for a tool, the time so spent is lost beyond recovery, and to insure the maximum output of any shop, such waste of time must be eliminated. To accomplish this, a number of tools of various kinds must be kept ready for immediate use to supply all requirements.

There are three distinct methods of fixing piece-work prices, which may be briefly illustrated as follows:

1st. Mike Maloney faces and rough turns a driving axle, diameter 8½ ins. Day rate, 30 cents per hour. He reports to his foreman that it took five hours to do the job, cost $1.50. Foreman figures that if a piece-work price is put on the job Maloney will do it in less time, so he deducts 25 cents, making the piece-rate $1.25.

2nd. Bill Jones, in another shop, performs the same work outlined above, same rate per hour, requiring the same time. The foreman knows that Jones is a good, honest whole-souled fellow, and, after adjusting his spectacles a few times, he concludes that a man working at a fixed rate for his product must apply himself more diligently to his work and should, therefore, earn more than his day rate, and on this reasoning the price is fixed at $1.75.

3rd. In still another shop Wm. Smith performs the same work. Day rate the same. In this shop, however, an entirely different course is pursued. The lathe and belting are carefully examined and put in good condition. The tool used is made of the best known grade of air-hardening steel and ground on a universal grinder to what is considered the best shape for the work. Carrying out the instructions of a man who has made a careful study of the work and knows what is necessary, the axle is put in the machine and the following time elements recorded:

Time required to change machine.
Time to chuck.
Time to face ends, each end separately.
Time to take rough cut.
Speed, feed and depth of cut.
Time lost, if any, on account of unavoidable delays.

Summing up, the inspector finds that it took two hours to complete the work. A detailed report is made to the foreman, and he is now in a position to recommend a fair and intelligent rate on this work, and when the rate is once fixed, nothing but a panic, requiring a general reduction in wages, or improved methods will ever require a change, and a change for either of these reasons cannot be charged as an element of unfairness in the piece-work principle.

Space forbids the extension of this article to the erecting and boiler shops, in both of which piece-work may be so applied as to be very profitable to both the men and the company. I can only add that in these departments the work must be thoroughly systematized and each individual operation carefully studied by a competent man before any rates can be permanently fixed. Any attempt to work the same gang all over an engine or on different parts of a number of engines will fall far short of securing the maximum output of the shop. Shoes and wedges may be assigned to certain men, guides and pistons to others, motion work to others, and so on. Similar divisions should be made of the work in the boiler shop, assigning all flue work to one gang of men, flanging to another, stay bolt work to another, etc. Here, as in all other departments, sound judgment must be used in wording the schedule in such a plain way that there will be no chance for a misunderstanding as to what any particular price is intended to cover.

(To be continued.)

RAILROAD SHOP MANUFACTURING.

Whether or not manufacturing locomotive parts in railroad shops pays, depends upon circumstances, upon machinery, men and specially upon the competency of the foreman. A decidedly important factor are the prices which can be obtained by the purchasing agent. At the Topeka shops of the Santa Fe, the brass department is fitted up to manufacture repair parts under the direction of an energetic foreman. A certain piece of work, consisting of 8 parts is made complete for $2.12, of which 73 cents is for labor, whereas the makers charge $18.00. This work is done on orders of perhaps 225 in one week. The work goes through in systematic order, each process being completed by itself and the parts passed on for the next step. By use of special undercut tools the work is done both rapidly and accurately and all such work for the entire road is concentrated here. This permits of keeping the department full of work and the machinery operates to good advantage.

One machine is occupied in making metallic rod packing at a labor cost of 5½ cents per set of 6 rings. Three-quarter-inch globe valves are made at a labor charge of 14 cents each. These figures are taken from the statements of the foreman and are understood to cover the actual cost of labor at the machines. Drain cocks are made in lots of 1,800 with a labor cost of 9 cents each, including grinding in on a special automatic machine. Allowing 23 cents for material, the cost is 34 cents each, against $1.19, the manufacturer's price. Hose nuts are made in lots of 200, with a charge of less than 2½ cents each, for labor. This department has the following machinery equipment:

2 20-in. and 1 24-in. American Fox lathes.
1 24-in. Lodge & Shipley brass lathe.
3 American and 2 Warner and Swasey 18 in. turret lathes.
1 15-in. Warner & Swasey Fox lathe.
1 2 spindle Warner & Swasey milling machine.
1 Large Becker-Brainard hand milling machine.
1 15-in. Pratt & Whitney plug lathe.
1 15-in. American engine lathe.
2 Jones & Lamson's turret stud lathes.
3 Niles and 2 Burden & Oliver turret stud lathes.
1 Special drain cock grinder.
1 Tool grinder.
2 Emery wheels.

The department employs 22 men and is located in the gallery of the Topeka locomotive shop.

HEAVY FREIGHT LOCOMOTIVES.

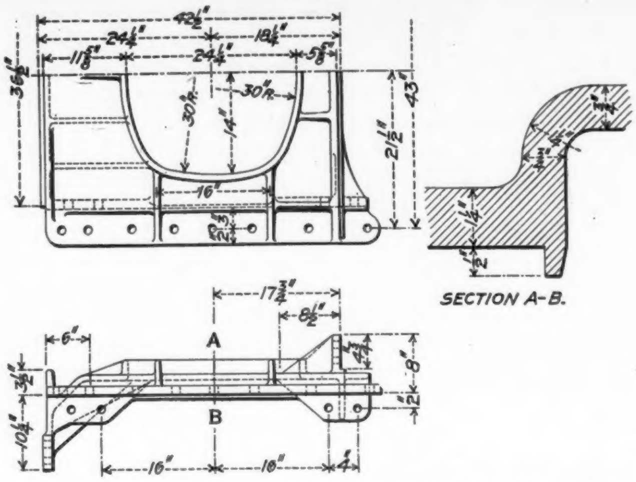
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

2-8-0 TYPE.

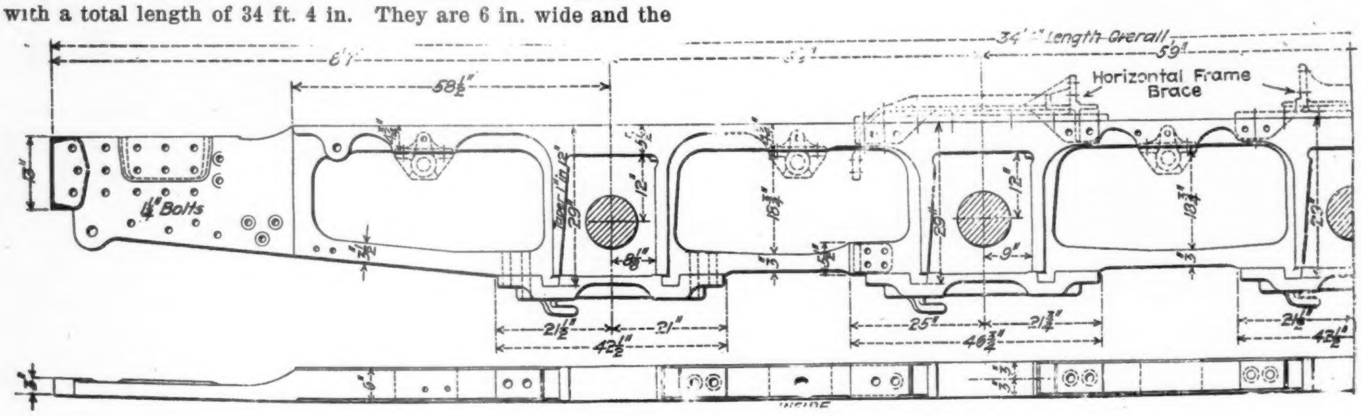
FRAMES, LEADING TRUCK AND ASH PAN.

The previous articles on this locomotive appeared in this journal in November and December of last year. The frames constitute a radical departure from ordinary construction and for that reason are presented in detail, and at the same time an account of some experiments to determine the deflection of locomotive frames in service is given in this number. This investigation, conducted by Mr. Vaughan led to the conclusion that diagonal bracing of the frames is necessary and consequently such bracing has been applied on these engines, such bracing has been sometimes provided at the mud ring, but this is the first application we have seen of this principle between the cylinders and the back end.

These frames are of cast steel and made in a single piece with a total length of 34 ft. 4 in. They are 6 in. wide and the sections were selected with a view of securing good castings. For example the fillets are large and I sections are used pretty nearly the full length of the frames. It is not a new plan for these builders to make frames in one piece, but they have never before, and it is believed that no one else has used a width of 6 in. In the recessed portions which are not machined the width is 5¼ in. This unusual width is given in order to increase the lateral stiffness of the frames and in this respect current practice seems to be deficient. For example, no one would think of raising a full length locomotive frame by a crane with a single sling in the middle of its length. If the

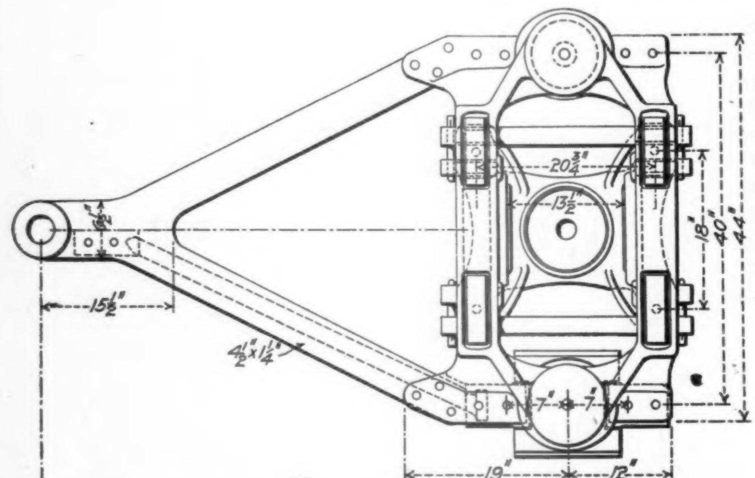


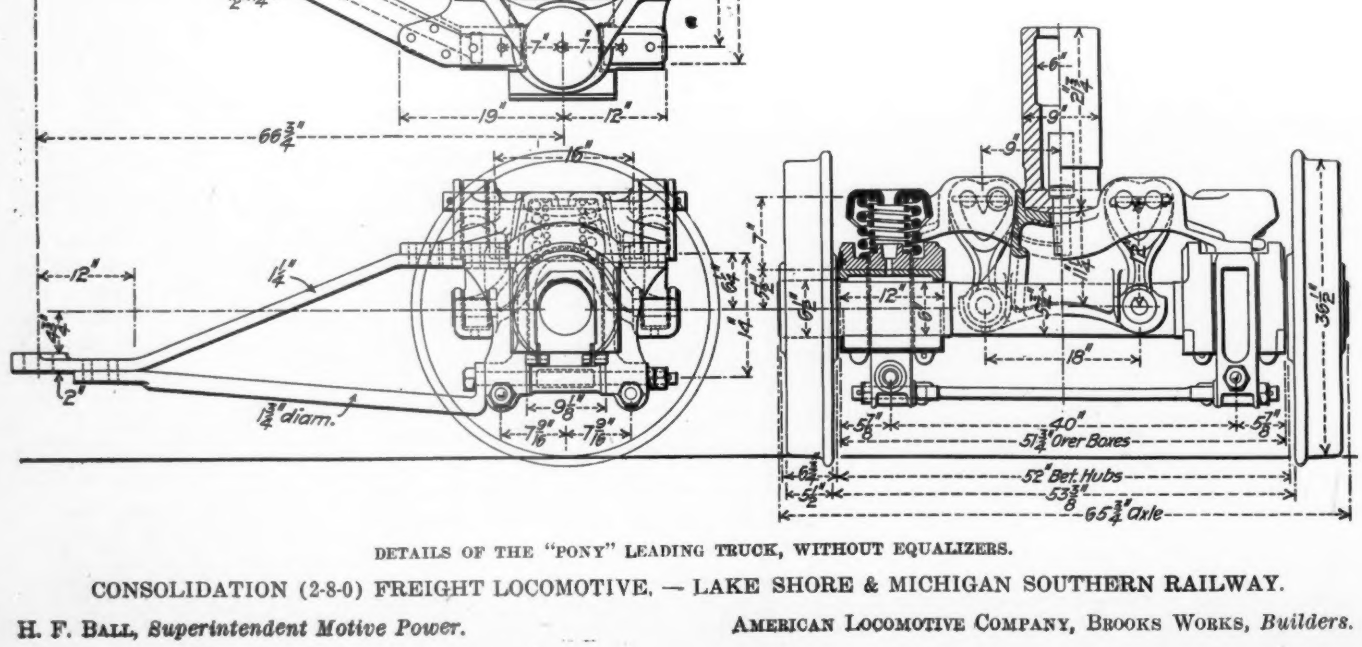
HORIZONTAL FRAME BRACE, OF CAST STEEL, OVER MAIN DRIVING AXLE.



ELEVATION AND PLAN OF CAST STEEL FRAME, MADE ALL IN ONE PIECE.

(Showing location of horizontal frame brace.)





DETAILS OF THE "PONY" LEADING TRUCK, WITHOUT EQUALIZERS.

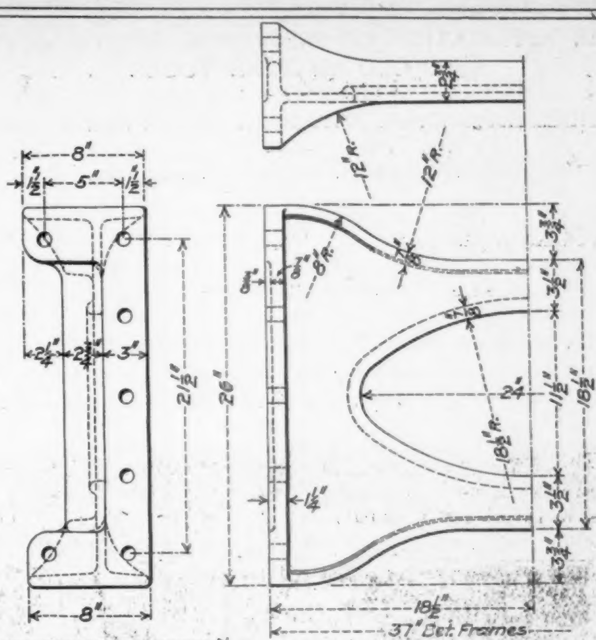
CONSOLIDATION (2-8-0) FREIGHT LOCOMOTIVE. — LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

H. F. BALL, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders.*

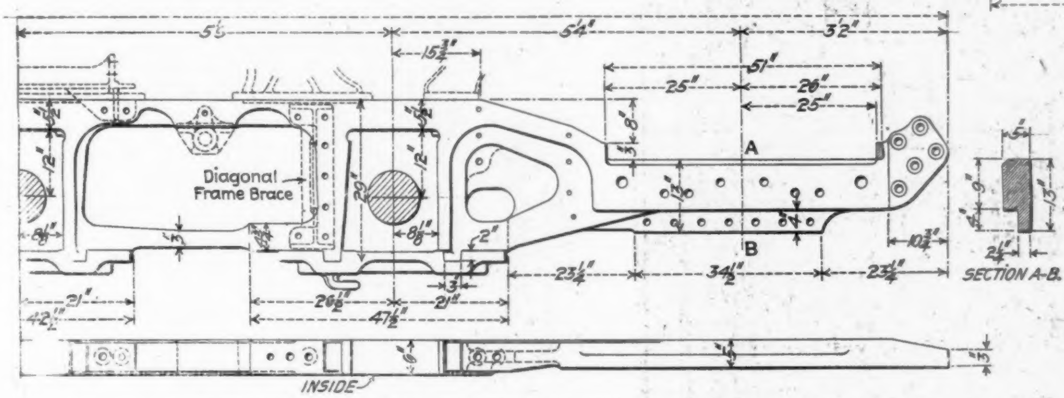
frame did not break it would buckle and spring under such treatment; yet the same frame is called upon to withstand the side thrusts of a heavy locomotive with no diagonal bracing.

While frames are stiff vertically and are tied to the boiler at frequent intervals and are also tied across the engine at the bottom rails, there has been nothing to prevent both bottom rails from moving laterally together and setting up torsional stresses on this account. This design includes a rigid front deck casting embodying the spindle guide and bumper brackets to which the frames are secured; it provides a wide cast steel cross-tie over the main driving axle, another over the third driving axle, a plate brace and cross-tie to support the front end of the firebox, giving diagonal bracing at that point, and a large, deep transversed brace in a vertical plane across the frames at the forward driving axle. Thus transverse, diagonal bracing is provided at the firebox end of the frames, and also at the forward driving axle.

This construction will be watched with great interest. If Mr. Vaughan is correct in the opinion of the importance of such diagonal bracing, as is given to bridge trusses, in the case of locomotive frames this design will mark a new departure in locomotive frame construction. On another page in this issue is printed an account of the experiments which led up to this form of bracing. (See page 8.)



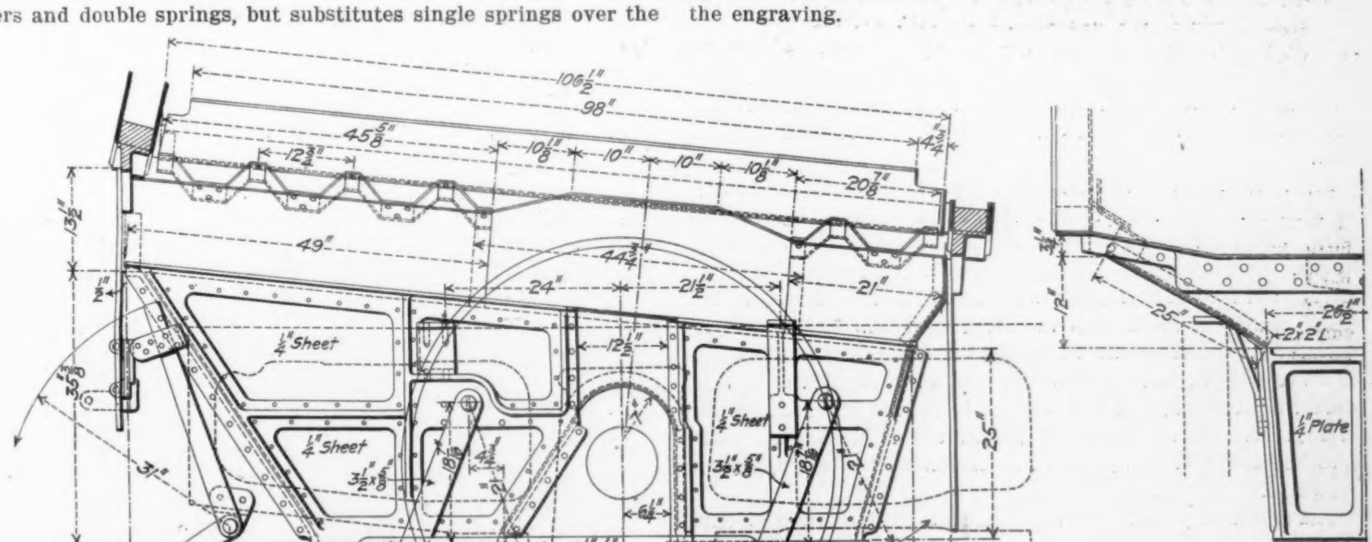
VERTICAL DIAGONAL FRAME BRACE OF CAST STEEL, AT REAR OF LEADING AXLE.



CONTINUATION OF FRAME, SHOWING LOCATION OF VERTICAL DIAGONAL BRACE.

In a two-wheel or "pony" truck, equalizers are useless as far as performing the equalizing function, as in a four wheel truck, is concerned. They serve to transfer the weight of the front end of the engine to points where it may be provided for. As usually applied they necessitate cutting away vital parts of the lateral ribs of the frame and they necessarily complicate the construction. This truck does not use equalizers and double springs, but substitutes single springs over the boxes after the method used in Fox trucks. This permits of securing ample strength in the frame casting, and it does away with a large number of parts. This truck has three point hangers 12 ins. long, calculated to offer an initial lateral resistance ratio of 0.146 of the weight on the truck. The design of this truck seems admirable.

About a year ago this road experimented with a new ash pan in order to avoid the serious trouble of cast iron hoppers cracking under the heat. The result was so satisfactory as to lead to the adoption of the new plan. This construction embodies a cast steel frame, with plate steel side sheets. The frame, being on the outside, is protected from the heat caused by accumulations of ashes inside the pan. All sheets are punched to templets, and if one burns out, it is easily replaced, involving no further injury to the ash pan. With this construction the Brooks hopper slides are applied as indicated in the engraving.



THE NEW ASH PAN CONSTRUCTION, OF PLATE STEEL SHEETS UPON A CAST STEEL FRAME.

THE APPLICATION OF INDIVIDUAL MOTOR DRIVES TO OLD MACHINE TOOLS.

McKees Rocks Shops.—Pittsburgh & Lake Erie Railroad.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

VI.

SLOTTING MACHINES.

The individual motor drive can usually be applied to an old slotter very easily and with very little expense, outside of the cost of the electrical apparatus. The question to be considered, on an old tool of this type, is not so much as to what speed the cutting tool will stand, but rather as to how many strokes per minute the tool itself can stand without excessive vibration.

Figs. 26, 27 and 28 illustrate the application of a motor drive to a 19 in. slotter, built by the Putnam Machine Co., Fitchburg, Mass., which was long in use at the old shops at McKees Rocks. In the case of this tool, the belt cone, which was formerly used for the drive, and to the end of which was keyed the small pinion to mesh with the large gear wheel, was simply replaced by a sleeve which had the small gear cut into its end to serve the purpose of the small pinion. The details of this sleeve, representing the only change in the machine, are shown in Fig. 29. On the sleeve is placed the Morse silent chain sprocket and a 24-in. fly wheel, as shown in the accompanying drawings.

The motor is placed on a railbase, so that slack in the silent chain can readily be taken up whenever necessary, and this base is in turn placed on oak blocking which is fastened to the floor. This raises the motor high enough above the floor to protect it from sweepings, etc., and since it is at the rear of the tool there will be no danger of cuttings falling upon it.

The large chain sprocket and the fly wheel were at first placed near the outer end of the sleeve thus allowing the motor to be brought quite close to the machine, and making the use of a very short chain possible; the vibration caused by the pull on the chain which varies at different parts of the stroke, due to reversal of the cutter head, was so great that it became necessary to move the sprocket and flywheel inward, and as close to the frame of the machine as possible. The distance between chain sprocket centers could be reduced somewhat, however, from that shown on the drawing, by allowing the corner of the motor to lap over the base of the tool. But the chain, as now in use, runs very smoothly and there is no whipping action caused by shocks due to reversal.

The range of speeds required on this tool is not very great, so that, on account of the complication which would be intro-

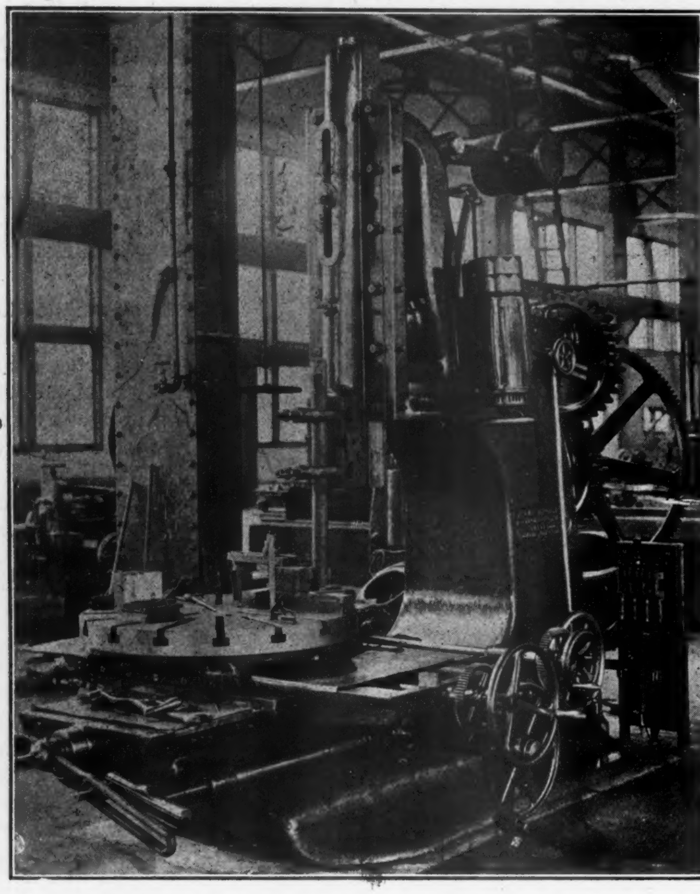


FIG. 26.—VIEW OF THE 19-IN. PUTNAM SLOTTER, SHOWING ARRANGEMENT OF CONTROLLER, TABLET BOARD, ETC.

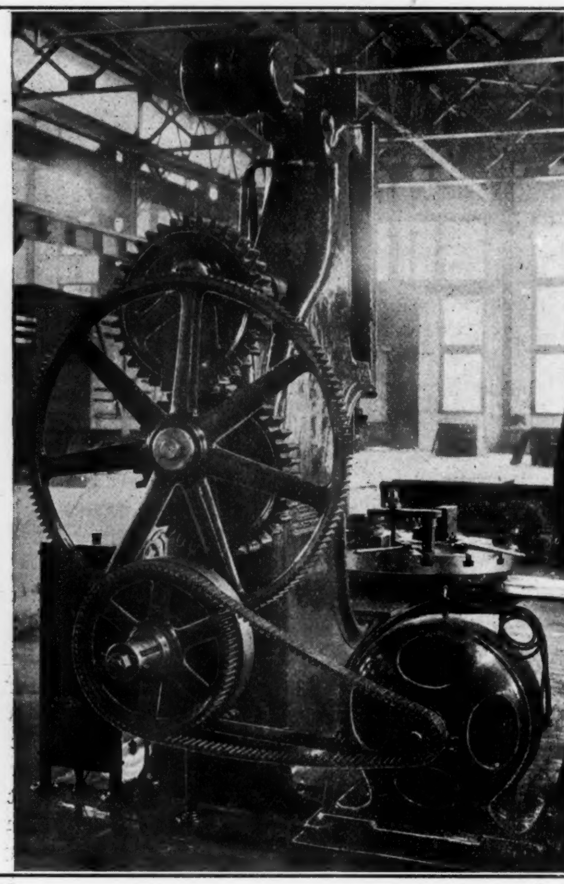


FIG. 27.—VIEW SHOWING DETAILS OF THE MOTOR-DRIVE ARRANGEMENT.—13-H.P. CROCKER-WHEELER MOTOR.

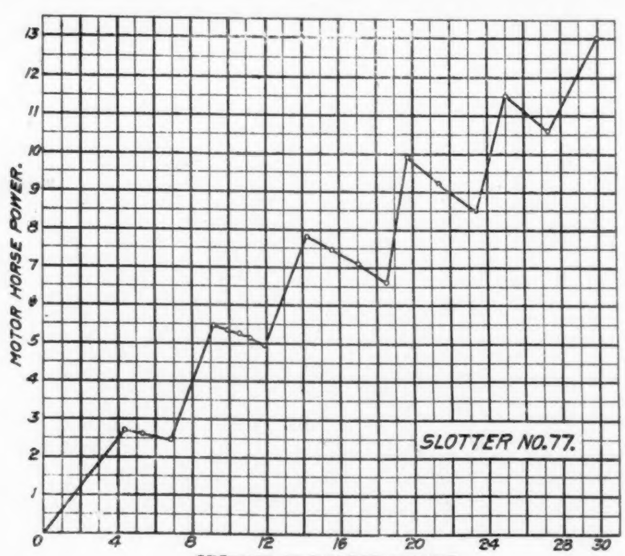


FIG. 30.—DIAGRAM TO SHOW THE VARIATIONS OF POWER, AS WELL AS ALSO THE NUMBER OF STROKES OF THE RAM FOR EACH CONTROLLER POINT.

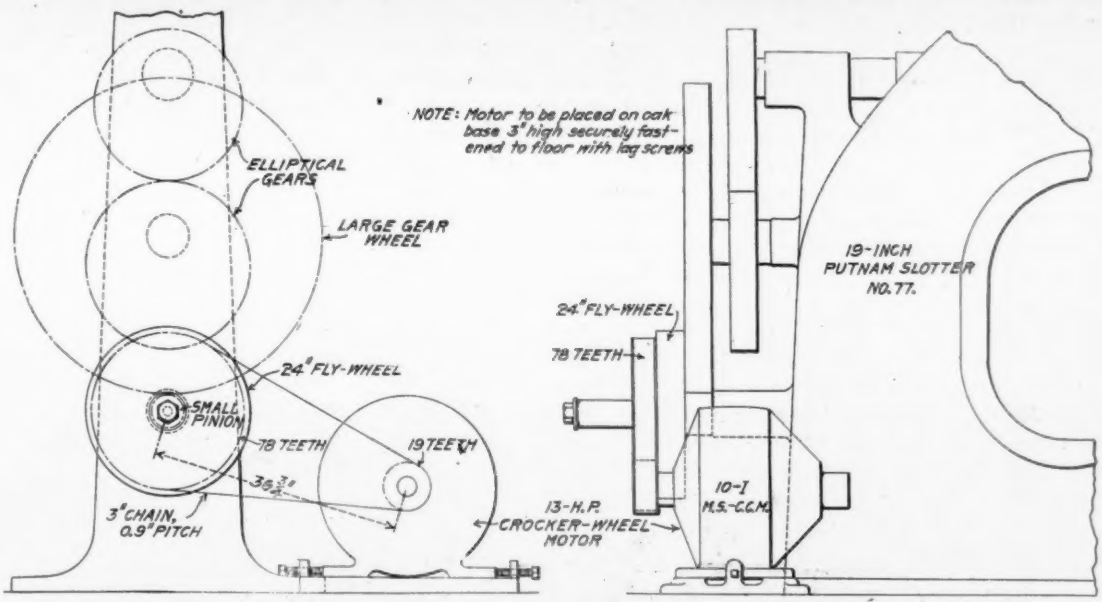


FIG. 28.—PARTIAL VIEW OF THE PUTNAM SLOTTER, SHOWING DETAILS OF MOTOR-DRIVE EQUIPMENT.

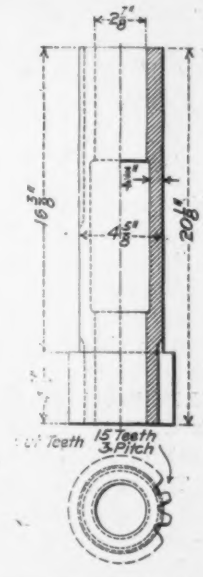


FIG. 29.—DETAILS OF THE NEW SLEEVE.

duced by adding another run of gears and a clutch, it was decided to merely use a larger motor—one of sufficient size to cover the entire range of speeds necessary. A multiple-voltage motor of the 10-I, M.S., C.C.M.-type, built by the Crocker-Wheeler Company is used, which will develop 13 h.p. at the full voltage of 240 volts (the term C. C. M. refers to the compound-wound type of motor). Fig. 30 shows diagrammatically the power available at, and also the number of strokes which the machine will make with each controller point. The controller is fastened to the side of the tool, as shown in Fig. 26, at a convenient point for the operator.

A few rough experiments have been made on this slotter, which was objectionable, since it had been thought best to keep all motor parts standard.

Fig. 31 shows the details of a motor-drive application to a 12-in. slotter, built by the Betts Machine Company, Wilmington, Del., which had also been in use at the old shops. The belt cone which received the drive, was in this case also, simply removed and replaced by the large Morse chain sprocket, as shown.

It was necessary here to place the motor directly under the arm which supported the old cone-shaft, so that the silent chain leading to this sprocket would not interfere with the arm.

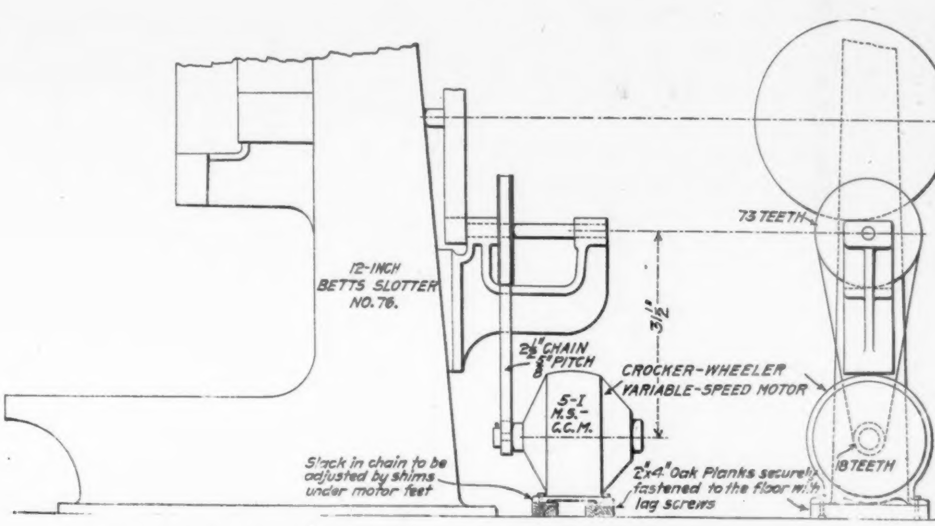


FIG. 31.—DETAILS OF THE MOTOR-DRIVE APPLICATION TO THE 12-IN. BETTS SLOTTER.

with the flywheel on the drive removed and with it in place, in order to determine its effect in assisting the motor at reversals. On account of the use of the elliptical gears which regulate the ratio of the speed of the return stroke to that of the cutting stroke, the speed of the head as it begins to reverse, accelerates gradually, instead of suddenly, as with the Whitworth motion. For this reason the increase of load on the motor due to the reversal of the head is not as great as it would be with the more sudden change. It amounts to considerable, however, and at long strokes the flywheel reduces the extra load on the motor to some extent.

The effect of the flywheel would be very much greater if it could be placed on an extension of the armature shaft of the motor, but this would necessitate a special armature shaft

The maximum number of strokes which this slotter can make with its new driving equipment is 35 per minute. The other details of this application are shown in the drawing, Fig. 31. No flywheel was used upon this drive.

The Crocker-Wheeler Companies type M. F.-21 controller is used for both of these slotter equipments. It had, at first, been thought advisable to use, for this class of tools, the type M. A.-12 controller, which will be remembered from the second article of this series to be the controller using resistance in the armature circuit to obtain the intermediate speeds. But after a series of tests it was decided to use the type M. F.-21 controller, which obtains the intermediate speeds by field control, although the latter type furnishes a somewhat greater speed range than is necessary for these tools.

HEAVY NEW FREIGHT LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

2—8—0 TYPE.

With considerable interest comes the announcement that the New York Central is receiving an order of 23 new consolidation locomotives, which are similar to the tandem-compound consolidation locomotives of the class "G-4," described on page 174 of the May (1903) issue of this journal, except that these are simple engines. These are known as class "G-5" in the locomotive classification of this road, and are somewhat lighter than the tandem-compounds. Their tractive effort, which is 45,700 lbs., is relatively high for their weight and heating surface. This gives them a rating of 45.7 on the 100 per cent. basis of 100,000 lbs., which is used on the New York Central.

The other interesting details of these locomotives are indicated in the following specifications. It will be noticed that a considerably larger and longer boiler is used on these engines than on the tandem-compounds, and still the heating surface is somewhat less. In the tandem-compounds 507 2-in. tubes are carried in a 77-in. boiler, while in these engines there are only 458 2-in. tubes in an 80-in. boiler; this cannot help but favor the steaming qualities of the boiler, and is commendable practice.

The following ratios and dimensions furnish a basis for comparison with other engines:

Ratios.

Heating surface to volume of cylinders	= 255.8
Tractive weight to heating surface	= 50.2
Tractive weight to tractive effort	= 4.29
Tractive effort to heating surface	= 11.7
Heating surface to grate area	= 69.2
Tractive effort × diameter of drivers, to heating surface	= 737.8
Heating surface to tractive effort	= 8.55%
Total weight to heating surface	= 56.1

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	219,000 lbs.
Weight on drivers	196,000 lbs.
Wheel base, driving	17 ft. 0 ins.
Wheel base, rigid	17 ft. 0 ins.
Wheel base, total	25 ft. 11 ins.

Cylinders.

Diameter of cylinders and stroke of piston	23 ins. x 32 ins.
Horizontal thickness of piston	6½ ins. and 7 ins.
Diameter of piston rod	4 ins.
Kind of piston packing	Cast iron
Kind of piston rod packing	U. S. Metallic with Gibbs Vibrating Cup

Valves.

Kind of slide valves	Piston
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 ins.
Inside lap of slide valves	Line and line
Lead of valves in full gear	Line and line at front; ¼ in. lead at ¼ cutoff
Kind of valve stem packing	U. S. Metallic

Wheels, Etc.

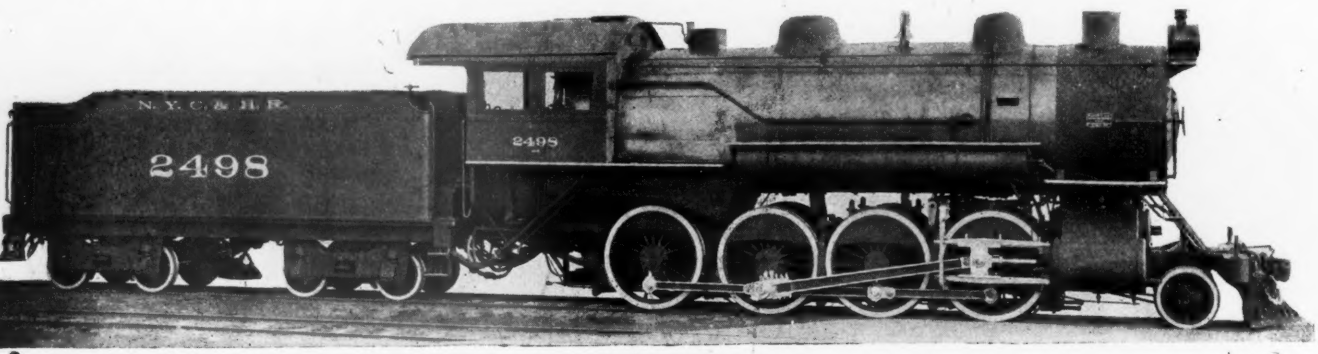
Diameter of driving wheels outside of tire	63 ins.
Material of driving wheels, centers	Cast steel
Tire held by	Shrinkage
Thickness of tires	3½ ins.
Driving box material	Cast steel
Section of rods	Main, I; side, I

Boiler.

Style	Straight top, radial stay
Inside diameter of first ring	80 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of fire box	13-16 ins., 9-16 ins., 1 in. ¾ ins., ⅝ ins.
Horizontal seams	Butt joint sextuple riveted
Circumferential seams	Double
Firebox, length	105 1-16 ins.
Firebox, width	75¼ ins.
Firebox, depth	front, 79⅛ ins.; back, 63⅓ ins.
Firebox plates	Sides, back and crown, ⅜ in.; tube sheet, 9-16 in.
Firebox water space	4½ and 5½ ins. front, 4½ and 6½ ins. sides, 4½ and 6 ins. back
Firebox crown staying	Radial
Firebox stay bolts	Taylor iron, 1 in. diameter W. S.
Tubes, material	Worth charcoal iron, No. 11 B. W. G.
Tubes, number of	458
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft. 6 ins.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,693.3 sq. ft.
Heating surface, water tubes	26.15 sq. ft.
Heating surface, firebox	182.5 sq. ft.
Heating surface, total	3,901.95 sq. ft.
Grate surface	56.43 sq. ft.
Ash pan	Sectional and hopper
Exhaust pipes	Single N. Y. C. standard
Exhaust Nozzles	6¼ and 6½ ins. diameter
Smoke stack, inside diameter	20 ins.
Smoke stack, top above rail	14 ft. 9¾ ins.

Tender.

Tender style	Water bottom
Weight, empty	54,100 lbs.
Wheels, number of	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	20 ft. 6 ins.
Tender frame	10-in. steel channels
Tender trucks	Two 4-wheel center bearing Fox pressed steel
Water capacity	7,000 U. S. gals.
Coal capacity	12 tons
Total wheel base of engine and tender	60 ft. 6½ ins.
Weight, engine and tender, working order	355,450 lbs.



NEW SIMPLE CONSOLIDATION FREIGHT LOCOMOTIVE. 2-8-0 TYPE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

AN EXTENSIVE WATER-SOFTENING INSTALLATION.

TOTAL CAPACITY, 348,000 GALLONS PER HOUR

PITTSBURGH & LAKE ERIE RAILROAD.

III.

THE MCKEES ROCKS WATER-SOFTENER.

As stated in the first article of this series, the largest and most important of the ten installations upon the Pittsburgh & Lake Erie for locomotive water supply is the softener located at McKees Rocks, adjacent to the roundhouses and new locomotive shops, this being the most important division point and point of heaviest water consumption upon the system. At this time, however, nearly all of the other locomotive water supply stations of the road are equipped with water softeners, of similar design, but smaller, ranging from 21,000 to 42,000 gallons capacity each, for treating the water before entering the storage tanks. In this article will be considered the details of the type of water-softeners used, which were all built and installed by the Kennicott Water Softener Company, Chicago, Ill., special reference being had to the McKees Rocks installation.

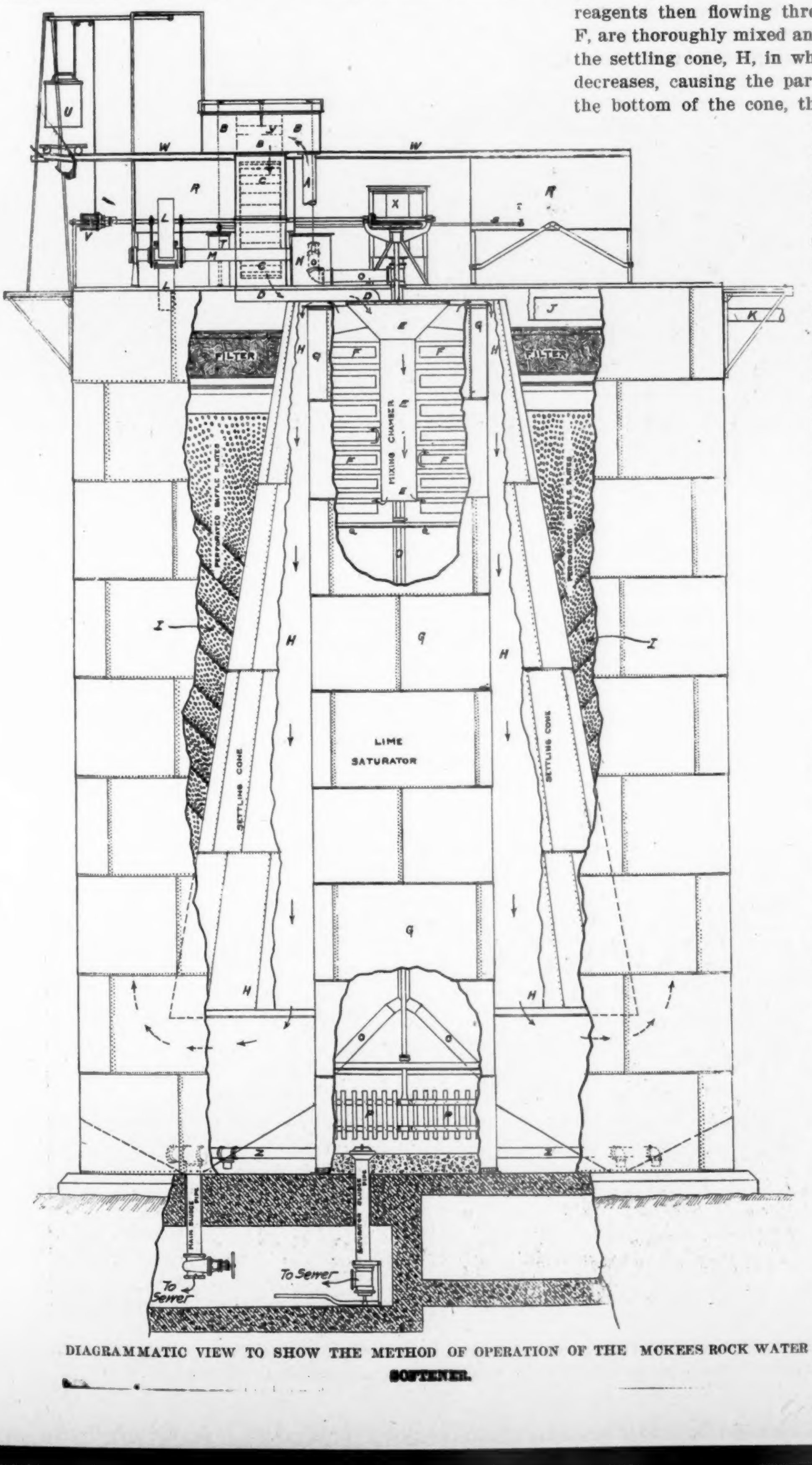
One of the water-softeners, built by the Kennicott Company,

installed at Buda, Ill., on the Chicago, Burlington & Quincy, was fully described on page 345 of the November, 1901, issue of this journal, but the changes and improvements that have been made upon the mechanical features of the Kennicott softener since that time make it necessary to completely review its construction. The accompanying engravings present a comprehensive idea of the McKees Rocks water-softener; the drawings illustrate its construction, both a diagrammatic view and a detail construction drawing being presented.

As before stated in this series, nearly all systems of softening water consist in the addition of soda and lime solutions of such strength as may be required by the quality of the "raw" water, and this is followed by the sedimentation of the treated water. In this system, the water is delivered from the source of supply through pipe, A, into the hard-water box, B, above the top of the settling tank, from which it passes through a slot in the bottom, the size of the slot being adjusted according to the amount of water to be treated. Within this box is a float, y, with chains passing over pulleys and connected to hinged inlet pipes in the two boxes or small tanks, N and T, which contain soft water, and the soda solution, respectively. The object of this arrangement is to vary the supply of the chemical solutions from these tanks, in accordance with the rate of supply of raw water, for the proper treatment.

The hard or raw water passing through the slot in the bottom of the tank, B, falls upon a water wheel, C, and thence through trough, D, into the mixing chamber, E, at which point the lime and soda solutions are added. The water and reagents then flowing through the revolving deflector plates F, are thoroughly mixed and agitated; next, it enters the top of the settling cone, H, in which the velocity of flow continually decreases, causing the particles held in suspension to fall to the bottom of the cone, the larger particles serving to carry the smaller ones with them. On reaching the bottom of the tank, the current is reversed, and the water then rises through a series of perforated conical baffle plates, I, as shown; at the same time the velocity still decreases, owing to the increasing diameter of the water space. These baffle plates catch and hold any remaining precipitate; the precijitate slides from these plates so that they never need cleaning. On reaching the top, the water passes upward through a filter compartment, filed with wood fiber, and enters a shallow soft-water tank, J, from which it flows through pipe, K, to the storage tank for supplying the boilers. The bottom of the large settling tank is of a conical hopper shape with discharge outlets for blowing out the sediment.

The lime solution is, in this softener, prepared in the vertical saturator or tank, G, which is located within the settling tank to prevent freezing, instead of outside, as was formerly the practice of the Kennicott Company. The lime is slaked in the box, X, at the top, soft water from the tank, J, being used for the purpose. The water is raised by a wheel, L, having hollow curved arms, open at the ends, which dip into the water, the water flowing through the arms into the hollow shaft, M, and thence into the tank, N, from which its flow to the saturator is regulated by the hinged inlet pipe already mentioned. The soft water is piped through pipe, O-O, to the lime box and thence to the bottom of the saturator, where it is stirred by an agitator or paddle, P, to thoroughly mix it, after which it rises in the cylinder until it enters into the mixing chamber, E, where it is thoroughly agitated with the raw water and the soda solution. The delivery, being by overflow, is always equal to the amount of soft water delivered to the saturator. The soda is placed in wire baskets in two tanks, R, R, from which the soda solution tank, T, is filled by

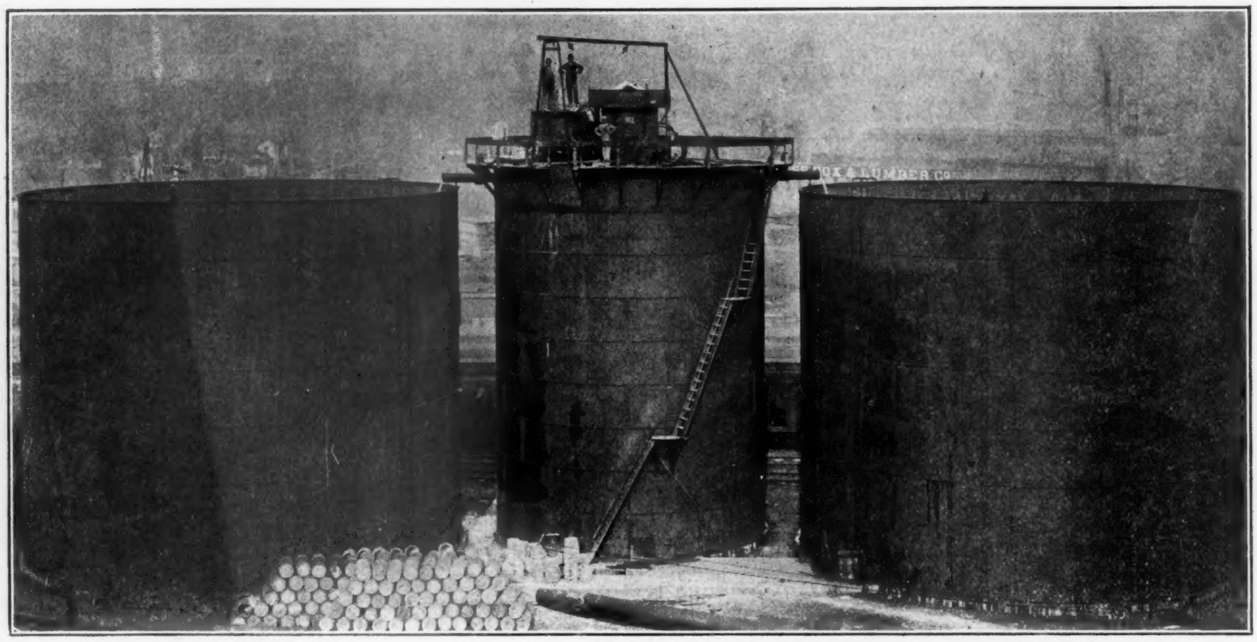


DIAGRAMMATIC VIEW TO SHOW THE METHOD OF OPERATION OF THE MCKEES ROCK WATER SOFTENER.

gravity; the supply of water to these tanks, R, is controlled in the usual manner by ball cocks and floats.

The very important features of this type of softeners are easily recognizable in the drawings. The thorough mixture of the chemicals and the raw water are provided for in the revolving mixing pot and deflector plates, F, in the mixing chamber, and after mixing, a very large storage is provided for the treated water to permit the chemical reactions to take place. The sedimentation chamber is of great size to allow plenty of time to the passing water to precipitate the scale-forming impurities. The cone system of arrangement of tank causes the water to flow with constantly decreasing velocity, so that, in

Another of the important features of the Kennicott water-softener is that, while a filter of the most approved type is provided to cleanse the water of the impurities as it is being delivered, it has little to do; the thorough and complete sedimentation process takes care of the greater part of the precipitation, or sludge, by favoring its gradual settling to the bottom of the tank, from which it may be drawn off periodically through the sewer connections. It is interesting to note in this connection that the main sludge-valve is opened twice a day, at each of which times over a ton of scale-forming matter is discharged in the form of a soft sludge. The filter is easily cleaned and practically no water is wasted in cleaning it; it is



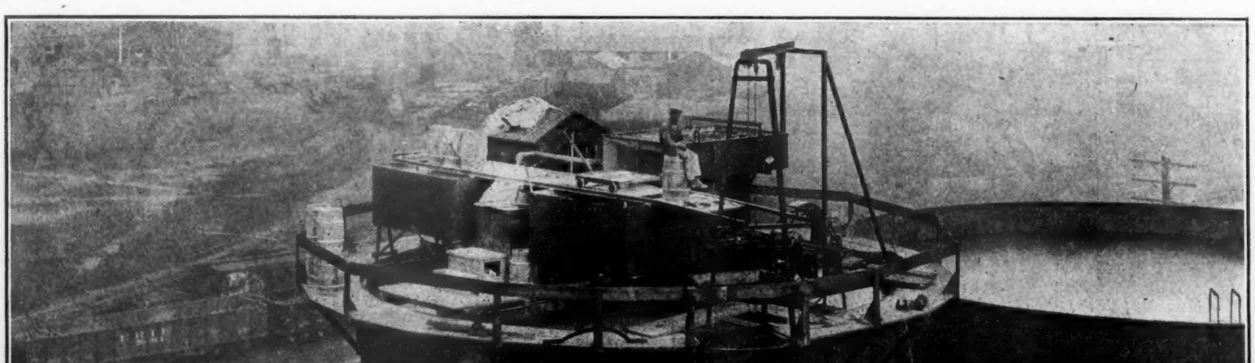
GENERAL VIEW OF THE LARGE KENNICOTT WATER SOFTENER.——CAPACITY 60,000 GALS. PER HOUR. ON EITHER SIDE IS A 500,000 GAL. STORAGE TANK FOR THE TREATED WATER SUPPLY FOR THE LOCOMOTIVES.

WATER SOFTENING INSTALLATION AT McKEES ROCKS.—PITTSBURGH & LAKE ERIE RAILROAD.

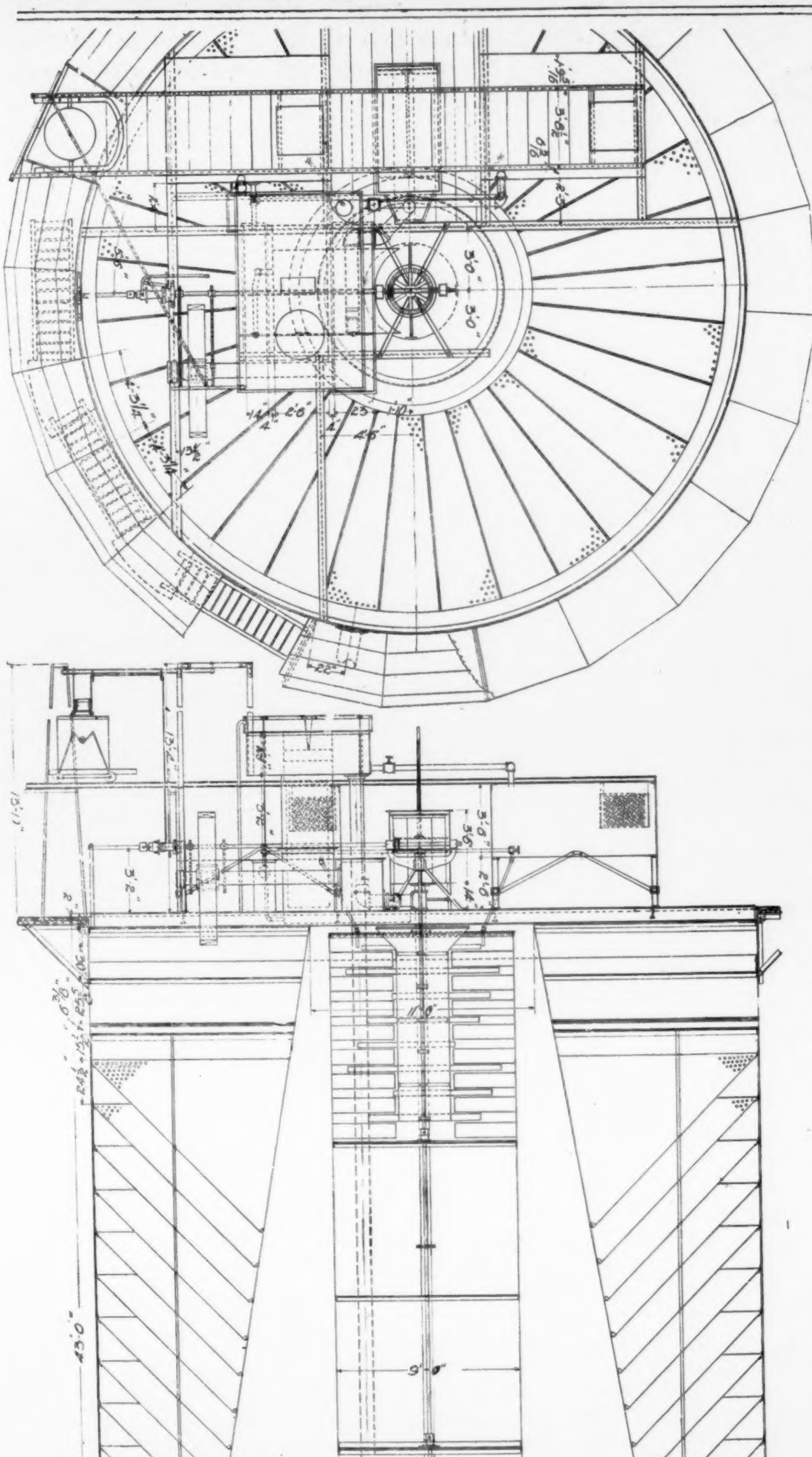
addition to passing through the same in the presence of previously precipitated old sediment and sludge (which is a very important factor, as it favors the precipitation of the impurities), it is comparatively at rest and free from agitation; this condition of precipitation is favored by the deflector plates, F, and also the perforated cone arrangement at I, all of which also tends to prevent any of the raw water from "by-passing," or getting ahead of any of the treated water which has already passed to the settling chamber.

only necessary to draw off the sludge, which drops the water level in the tank down below the filter, which causes the water to flow backwards through the filtering material, thoroughly cleaning it. This material is usually wood fiber, or excelsior.

A most important feature of the Kennicott softener is the apparatus for regulating the flow of the chemical solutions into the mixing chamber for action upon the raw water. The chemicals used, which are lime (for the removal of carbonates of lime and magnesia) and soda ash (for the removal of sul-



AN INTERESTING VIEW OF THE TOP OF THE MCKEES ROCKS WATER SOFTENER (TAKEN FROM ROOF OF THE ERECTING SHOP), SHOWING ARRANGEMENT OF APPARATUS. LARGE SQUARE SODA TANKS AND HOISTING APPARATUS IN FOREGROUND.



PLAN AND ELEVATION VIEWS OF THE McKEES ROCKS WATER SOFTENER, SHOWING DETAILS OF CONSTRUCTION.

phates of lime and magnesia), are automatically mixed and agitated, and are fed into the raw water at a rate depending upon the flow of raw water into the apparatus. If the water is entering rapidly, the flow of the chemical solutions increases, and vice versa. The details of the apparatus for accomplishing this end will be fully illustrated and described in the next article of this series.

A few of the interesting features of construction of this large softener at McKees Rocks should be here referred to. As may be noted from the detail construction drawing, the main tank is 32 ft. 7 ins. in diameter and 43 ft. high. An idea of the size of this tank may be gained from the view of the plant on page 18. The large storage tanks for treated water, one of which is located on each side of the softener, are each 50 ft. in diameter and 40 ft. high, each having a capacity of 500,000 gals. of water.

The lime saturator tank, which is located within the main tank to prevent freezing, is placed concentric with the outer tank and is 9 ft. in diameter. The upper end of this tank is utilized for the mixing chamber and the deflecting and mixing vanes, F. Then around this tank is the cone which forms the settling chamber; this cone, which is 35 ft. high, is 11 ft. in diameter at the top and 23 ft. in diameter at the opening at the bottom.

The bottom of the main tank is filled in with a concrete filling, surrounding the lime saturator tank, to provide sloping conical surfaces directed toward the large sludge-discharge outlets. These outlets are of large pipe with projecting nipples pointing down to the lowest portions of the slude pit, so that in discharging all the sludge will tend to be removed first.

The interesting details of the automatic features of this apparatus will appear in full in our next issue. The entire installation of water softeners upon the Pittsburgh & Lake Erie was designed and buit by the Kennicott Water Softener Company, Chicago, Ill.

(To be continued.)

PERSONALS.

Mr. P. H. McGuire has been appointed master mechanic on the Great Northern. He will have charge of the Superior & Mesabi divisions, with office at Superior, Wis., vice Mr. G. A. Bruce, promoted.

Mr. T. M. Ramsdell, who was recently appointed master car builder of the Chesapeake & Ohio, will have his headquarters for the present at Richmond, Va. He will look after matters pertaining to car building and repairs, and will report to the superintendent of motive power.

Mr. Thomas Roope has been appointed to the position of assistant superintendent of motive power on the Chicago, Rock Island & Pacific, with headquarters at Topeka, Kan. This office has just been created. He was formerly general master mechanic on the Great Northern.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

PUBLISHED MONTHLY BY

R. M. VAN ARSDALE,

J. S. BONSALL, Business Manager.

140 NASSAU STREET..NEW YORK

G. M. BASFORD, Editor.
C. W. OBERT, Associate Editor.

JANUARY, 1904.

Subscription.—*$2.00 a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscriptions for this paper will be received and copies kept for sale by the
Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa.
Century News Co., 6 Third St. S., Minneapolis, Minn.
Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C., London, England.

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS.

On page 6, of this issue, appears an account of some of the interesting experiences which Mr. Basford is meeting on his trip through England, where he is at present. From there he will go to France. Further selections from his correspondence will appear in the next issue.

THE ECONOMY OF THE RAPID DRIVER-TIRE BORING OPERATIONS.

On another page of this issue appears an interesting communication from Mr. J. H. Pattison referring to the article on page 420 of our November issue, relative to the remarkably rapid tire-boring performance in daily practice at the Albany shops of the New York Central. Mr. Pattison discusses the economy of this practice, in relation to the number of helpers required, in a very interesting way; the tabular comparison showing the actual cost of this work per tire is valuable and will prove a revelation to a great many who have previously been satisfied with the old methods of performing this work.

The striking feature of this comparison is, however, that at the Roanoke shops one helper only is required for placing tires on two boring mills, with the aid of adequate crane facilities. This seems to be a decisive argument, backed up by the convincing proof of actual saving, in favor of liberally providing railroad repair shops with crane facilities. It is seldom that we are enabled to present the result upon a particular machining operation, in dollars and cents, of furnishing crane service for the tools.

We hope that these articles will prove of sufficient interest to bring forth further comments from those who have had experience along these lines. In the two articles referred to, most excellent results have been obtained from the machining processes, but, as shown by Mr. Pattison, there is another question to be decided in this connection, and that is, as to whether the conditions under which the machines are being operated are favorable to the greatest economy, or not.

THE ADVANTAGES OF THE WATER SOFTENING PROCESS FOR LOCOMOTIVE WATER SUPPLY.

Criticisms have been offered to the statements, made in our recent article relative to the Extensive Water Softening Installation upon the Pittsburg & Lake Erie Railroad (page 449, December, 1903), as to the loss of fuel due to the effect of scale in the boilers. The statement is sometimes made, and is believed by some, that a crust of scale covering the heating surfaces of a boiler does not retard the transfer of heat from the fire to the water; this belief has its origin in a single set of experiments, crudely conducted some years ago to determine the relative heat conductivity of boiler tubes when clean and when covered with scale. These experiments were, unfortunately, limited by the gross error of having been conducted at a low temperature, so that a true comparison could not be made with the conditions that exist in boiler practice.

In the tests referred to, the above-mentioned, and rather odd, conclusion was arrived at from the length of time which was required by two bodies of water, one surrounding a clean tube and the other a scaled tube, to be raised from cold to the temperature of boiling; inasmuch as the times required were in both cases about the same, it was concluded that no retarding effect was offered by the scale to the transfer of heat. That this is erroneous is evident from the fact that a high temperature was used in heating the cold water, so that a great difference of thermal potential was offered; furthermore, no quantitative test was made. The conditions in a locomotive boiler are far different from the simple conditions offered in such a test, in that the thermal potential difference is much less—particularly so with the high steam pressures that are now being used—and also in that heat is transferred into the water in immense quantities per unit area of the heating surface.

We are not aware that any such experiments have been performed under the true conditions of modern boiler practice,

which will indicate anything but the fact that scale on heating surfaces has a great retarding effect upon the transfer of heat; this has certainly been proved beyond all possibility of doubt by the experience of the Pittsburg & Lake Erie Railroad Company. The above-mentioned absurd conclusions from a single set of laboratory experiments have been quoted and re-quoted by various authorities without thought of questioning their validity.

The statement in the above-mentioned article that ⅛-in. of scale upon the heating surfaces of locomotive boilers may be taken as representative of average conditions in this country, may be affirmed by the following remarks of a prominent motive power official of one of our Western railroads, which uses waters comparatively free from scale-forming impurities. He states: "The scale conditions which we meet in operating our locomotives vary according to the waters used. In some districts where we have proportionately very large quantities of carbonate of lime in the water, we are running up as high as 3-16-in. scale on our flues, and on other roads where the water conditions are worse, the scale thickness will go even higher than that. On some other division we will not have, at the end of a year, more than probably the thickness of an egg shell. Of course ⅛-in. of certain kinds of scale is worse than 3-16-in. of some other kinds of scale; where it may happen to be straight carbonate of lime, a scale of 3-16-in. on the flue, will, with the water boiling around it, soften, and the heat penetrates, while with some other scale, where we have sulphate of lime, it is so hard that hot water has no effect on it, and it causes a complete insulation of the tube, to which the water does not get very easily. In the case of crown sheets, where the old crown bars were used, we would sometimes find ½-in. scale there and in cases of excess, ¾-in.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-eighth meeting of the American Society of Mechanical Engineers was held from December 1st to 4th, last, at the society's headquarters, 12 West 31st street, New York. It began with an informal reception on Tuesday evening, December 1, at which time the president delivered the annual address. The various sessions between this opening and the most instructive closing were full of interest, and were attended by the usual features of a pleasant and enjoyable nature. Many interesting papers were presented, and the discussions were interesting and instructive. An interesting feature of the meeting on December 3d, which was held at Steven's Institute, at Hoboken, N. J., was an illustrated lecture upon "Thermit."

Further reference will be made to the papers presented at this meeting. The paper, entitled: "What are the New Machine Tools to Be?" by John E. Sweet, is reproduced in abstract on page 33 of this issue.

The feature of the closing day was the trip to the De Laval Steam Turbine Co., at Trenton, N. J., who placed a special train at the disposal of the society. The most interesting exhibit there was a test under way of one of the new De Laval two-stage series centrifugal pumps which was pumping 400 gallons of water per minute against a delivery pressure of 200 lbs. per sq. in., requiring 58 horsepower to do so.

COMMUNICATIONS.

THE RECORD-BREAKING TIRE-BORING OPERATION

To the Editor:

On page 420 of the November, 1903, issue of your journal, there appeared an article from Mr. Albert H. Reese, of the New York Central Railroad shops at West Albany, N. Y., relative to a remarkable record in boring driving-wheel tires. This work, we have since been informed, was performed on an extremely large and heavy boring mill, built by the Betts Machine Company, Wilmington, Del., having a bed about 11 ins thick and other parts built in proportion. This is surely a very extraordinary machinery record for this class of work and Mr. Reese is entitled to much credit for his efforts in running this tool up to its maximum capacity.

Since reading the article referred to above, however, we have given this subject some little attention, and the following table shows in detail some of the results we have been able to accomplish on 56-in. Latrobe steel driving tires:

ECONOMICAL TIRE BORING.—NORFOLK & WESTERN RAILWAY.

Number.	Cutting Speed (Ft. per Min.).	Feed per Revolution, Rough Cut.	Feed per Revolution, Finish Cut.	Time of Rough Cut (Minutes).	Time of Finish Cut (Minutes).	Time to Set Tire (Minutes).	Time to Remove Tire (Minutes).	Time Lost in Changing Tools, Etc.	Total Time (Minutes).
1	28	¼	⅝	7	8	9	4	3	31
2	22	¼	⅝	9	10	6	4	2	31
3	33	¼	⅝	6	8	7	2	3	26
4	28	¼	⅝	7	8	7	4	2	27
5	22	¼	⅝	9	10	6	3	2	30
6	22	¼	⅝	9	5	7	3	2	26
7	23	¼	11-16	7	4	6	3	3	23
8	37⅓	1-6	1-6	15	..	8	3	4	30
9	37⅓	1-6	1-6	14	..	6	2	2	24
10	37⅓	1-6	9-16	7	3	6	4	3	23

The first seven tires, referred to in the above statement, were bored on a Niles boring mill which has been in constant use for more than 20 years. The bed on this machine is now less than 3 ins. thick at the edge. The feed gear, with which it is equipped, is so arranged that the tools will not follow each other, but meet in the center of the work, one feeding upward while the other feeds down. This, however, is no objection for this particular class of work, as any machine operator can soon demonstrate to his entire satisfaction that the quickest way to bore a tire is to rough out with both tools and then finish with a wide tool and a feed of ½-in. to 1-in. per revolution. The finish cut on the tires in tests, Nos. 6 and 7, was fed by hand, as a ⅜-in. feed is all that we can get on this tool by means of the feed gear. It will be noted that the rough cutting speed on the tire in No. 3 was 33 ft. per minute and while the tool will do good work at this speed, on account of the age and worn condition of the machine, we were not able to maintain it.

The last three tires referred to in the table were bored on a Niles boring mill that has been in service at the Roanoke shops about three years. On this machine we were able to run at a rough cutting speed of 37 1-3 ft. per minute—a safe speed for the Allen tool steel which we are using on these machines; but on account of the countershaft being located very close to the main shaft we were not able to take the proper amount of feed in roughing out on account of the belt slipping.

There remains one element to be considered, however, which is not mentioned in the above table, and that is the time necessary to bring the tires into the shop and remove them again. As our tires are unloaded from the cars at some distance from the shop, it requires about five minutes per tire on an average, for each of two men to bring them into the shop, and about two minutes per tire to take them out, as they are dropped just outside the shop where they are afterward put on the wheels. It requires but one helper in our shop to assist in setting and removing tires on the two machines referred to above, his time being about equally divided between the two, as all lifting is done by pneumatic hoist and walking crane.

Assuming, then, that the mechanics in both the Roanoke and the West Albany shops are paid $5.00 per day, and helpers $1.25 per day, a comparison of the actual cost per tire in the two shops would, on a basis of finishing 10 tires, be as follows:

Roanoke Shops.—Norfolk & Western Railway.

Time of mechanic, 4⅔ hrs., at 50c. per hr.	$2.33
Total time of one helper, 4⅔ hrs., at 12½c. per hr.	.58
Total	$2.91
Average cost per tire	.29

West Albany Shops.—New York Central.

Time of mechanic, 3⅔ hrs., at 50c. per hr.	$1.83
Total time of the four helpers, 14⅔ hrs., at 12½c. per hr.	1.83
Total	$3.66
Average cost per tire	.37

J. H. Pattison, Foreman Machine Shop.
Roanoke Shops, Norfolk & Western Railway.

Roanoke, Va.

NEW LOCOMOTIVE AND CAR SHOPS.

McKEES ROCKS, PA.

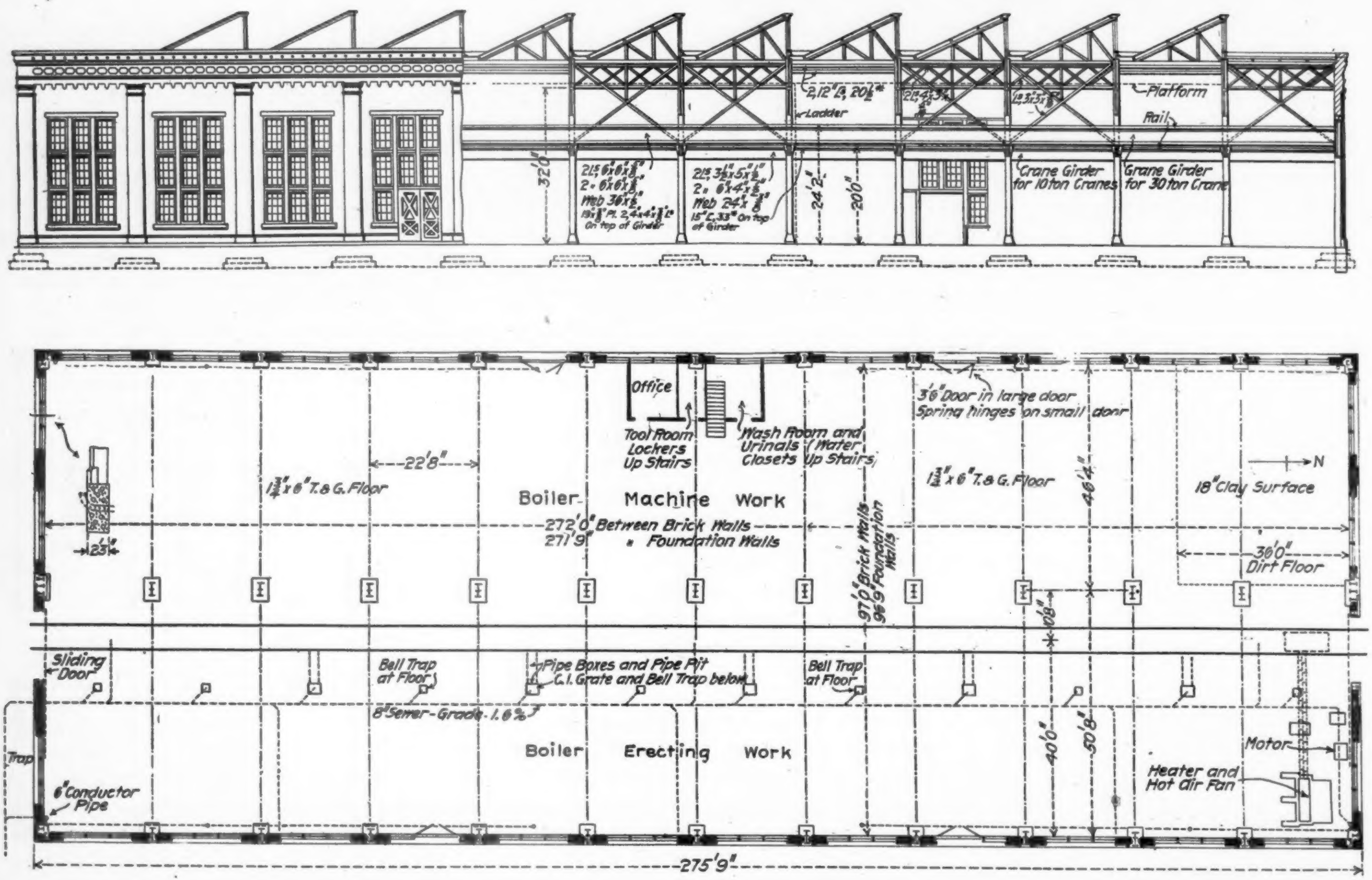
PITTSBURGH & LAKE ERIE RAILROAD.

III.

THE BOILER AND THE BLACKSMITH SHOP BUILDINGS.

In the preceding article the steel work and constructional details of the erecting and machine shop building were illustrated. In this article will be presented the interesting features of the boiler and tank shop building and the blacksmith shop building. We are fortunate in being able to procure, through the courtesy of the engineering department of the system, excellent photographs of the various buildings, which were taken by Mr. R. T. McMasters of that department, the views were well selected to illustrate the interesting features of the shop buildings.

VIEW OF THE BOILER SHOP BUILDING FROM THE EAST.



PART ELEVATION AND PART LONGITUDINAL SECTION, AND PLAN OF THE BOILER AND TANK SHOP BUILDING.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

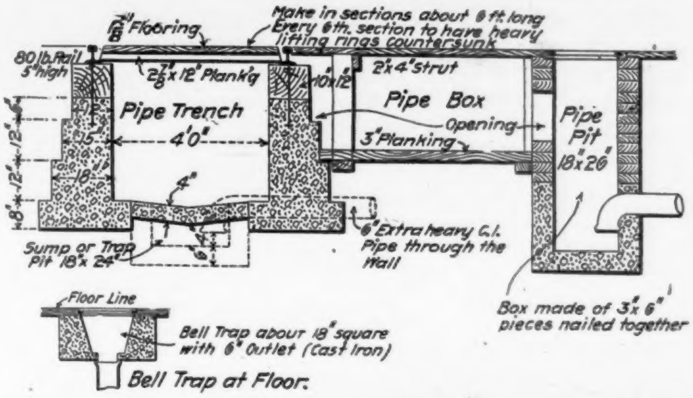
CONSTRUCTION VIEW OF THE BOILER SHOP BUILDING.

These buildings are both of the steel skeleton construction, similar to that used in the main shop building, with the brick work merely tied to the frames for stability. They are of unusually strong and heavy construction and yet, like the erecting and machine shop building, are designed to present symmetrical lines and a pleasing appearance. The design of cornice used is the same on both buildings as upon the main shop building, which serves to unify the appearance and add the neatness of exterior which offsets the extremely plain and business-like design of these structures. Excellent provision for daylight lighting also characterizes these buildings, as may be seen in the exterior views.

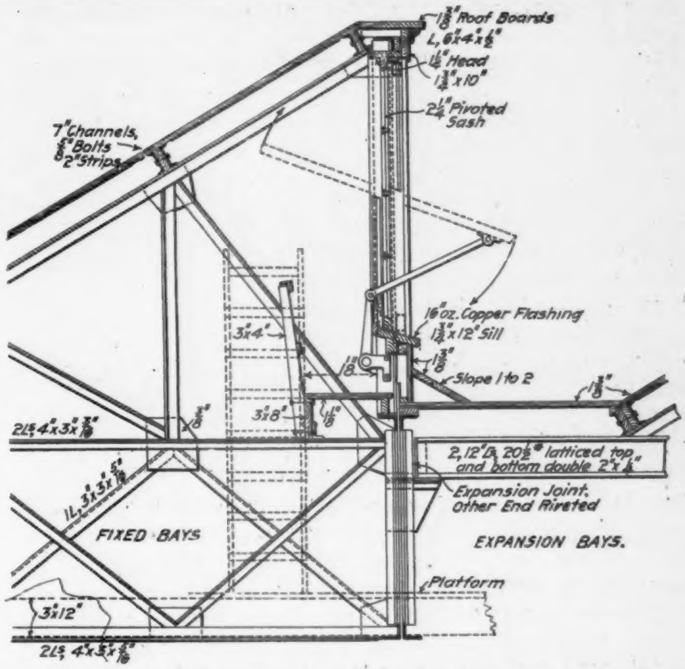
The steel work for these two buildings was also designed by Mr. Albert Lucius, consulting engineer of New York, and it was erected by the McClintic-Marshall Construction Company, Pittsburg, Pa., who erected the machine and erecting shop building.

THE BOILER AND TANK SHOP.

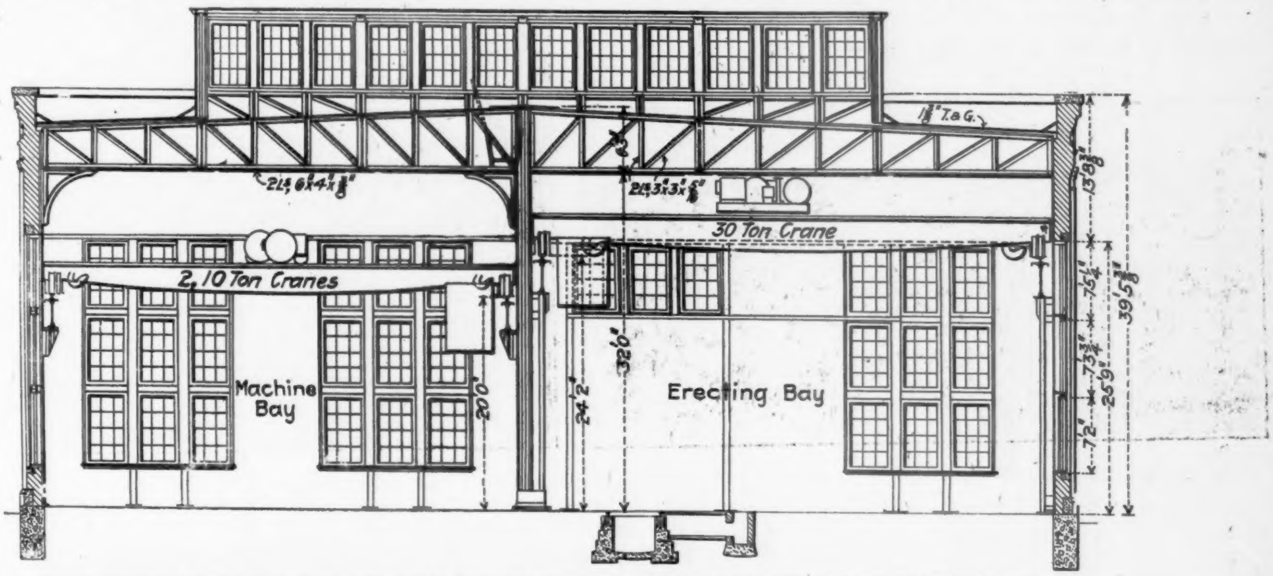
This building is conveniently located to the north and extending at right angles to the main shop. It clears the main shop by 24 ft. between exteriors, thus leaving an ample passageway and yet reducing the distance for carrying material to a minimum. Direct communication is afforded between the two buildings by a track running lengthwise of the boiler shop just to the east of the center line of columns, which extends through and connects with engine pit No. 5 (from the east end) in the erecting shop, so that boilers may be transferred to and from the boiler shop with the greatest possible facility. A considerable space is left open at the east side of this building, for a wheel unloading platform and an entrance track to the main shop; on the west is a space of 50 ft. which separates this shop from the blacksmith shop (see layout plan of the shops, November, 1903, issue, page 396).



CROSS-SECTION OF THE PIPE TUNNEL, SHOWING DETAILS OF CONSTRUCTION AND THE DRAINAGE SYSTEM.

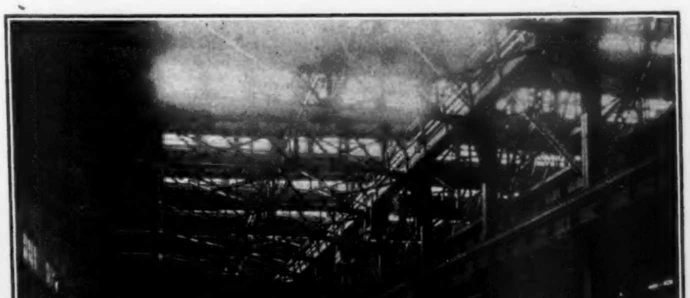


PART VERTICAL LONGITUDINAL SECTION THROUGH THE BOILER SHOP ROOF, SHOWING DETAILS OF SAW-TOOTH CONSTRUCTION.



CROSS-SECTION VIEW OF BOILER AND TANK SHOP BUILDING, SHOWING ARRANGEMENT OF TRAVELING CRANES.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.



INTERIOR VIEW OF THE BOILER AND TANK SHOP, IN BOILER MACHINE BAY. (LOOKING NORTH.)

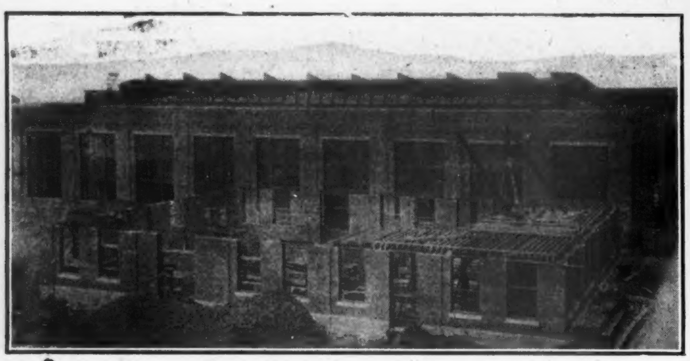
The boiler shop is 275 ft. 9 ins. long and 100 ft. 9 ins. wide, outside, and 272 ft. x 97 ft. inside the walls. The building is divided into two bays by a line of columns extending lengthwise through the shop; the bay on the west side, which is used for the boiler machine tools and plate machinery, is 46 ft. 4 ins. wide, and the erecting bay on the east side, which contains the longitudinal entering track, is 50 ft. 8 ins. wide. The center columns, which are symmetrically located in relation to the side wall columns, are placed 22 ft. 8 ins. between centers, and as shown in the longitudinal elevation view, each span between columns carries one of the saw-tooth sections of the roof. The longitudinal track through the building is located close to the center row of columns, the nearest rail clearing them by 6 ft. 5 ins.

The general plan of the steel work in this building does not

differ greatly from that of the main shop buildings. The weight of the roof and of the cranes, is here also provided for solely in the columns, and construction was simplified by making all columns similar, in detail, as far as possible. Longitudinal bracing is provided for in this structure in the two end spans between center columns, and alternately thereafter in groups of two spans each, as indicated in the longitudinal section. An excellent idea of the character of the steel work is to be had from the interior view of the boiler shop, and also the construction views which were furnished by the courtesy of the engineering department.

The floor in this building is made up of 1¾-in. yellow pine plank, dressed and matched, laid on 4 x 4-in. sleepers, which are bedded in sand on earth filling. In this building, however, the electrical distribution system is carried overhead along the side wall, reference to which arrangement will be made in a later article. In the north end of the boiler machine bay the floor is interrupted for a space of 36 x 45 ft. A dirt floor is here provided to accommodate the flue work furnaces and other furnaces required in this shop; this dirt floor is faced with 18 ins. of clay, both the filling underneath and the clay surface having been thoroughly tamped in place.

The roof on this building is one of the most important features. The saw-tooth arrangement of skylighting is used, and in this case it was necessary to locate the windows crosswise of the roof in order to obtain the desired north light. The saw-tooth construction is carried by longitudinal lattice girders built in between the roof trusses in the rigid spans, being omitted in the expansion spans, as shown in the longitudinal



VIEW OF THE BLACKSMITH SHOP BUILDING FROM THE WEST, BEFORE COMPLETION OF STOREHOUSE BUILDING.

of this construction are shown in the building cross section and also in the detail drawing. This tunnel is located beneath the longitudinal track and extends the entire length of the building. The details of the concrete construction, together with the arrangement of the sumps, or trap pits, for drainage, is clearly indicated in the detail sketch. At five points cross pipe box connections are made to the pipe pits, as shown, which serve as outlets for all pipe connections from the tunnel, and also for drainage for the erecting bay floor. At seven other intermediate points along the floor, bell-trap boxes are also provided for additional drainage; one of these bell-traps is also shown in sectional detail. Besides making an excellent outlet system for steam, water and air supply pipes, this arrangement provides a most complete and convenient drainage system, which is so necessary in this shop.

THE BLACKSMITH SHOP BUILDING.

This building is located to the west of the boiler shop and north of the erecting and machine shop, clearing the same by the same distance, of 24 ft., as the boiler shop. It also has direct communication with the main shop by a track extending longitudinally through it and connecting with the track on pit

INTERIOR VIEW IN THE BLACKSMITH SHOP, SHOWING PROVISION IN THE ROOF STEEL-WORK FOR THE JIB CRANE SUPPORTS.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

elevation. The remaining interesting details are made clear in the detail cross section of one of the saw-tooth skylights. Liberal provision for platforms and connecting walkways has been made, each set of windows having a platform and railing for cleaning, etc. Inside rain conductors are provided for the roof drainage, to eliminate troubles from freezing in cold weather, and the roof covering used is identical with that on the machine shop.

Liberal crane facilities have also been provided for in the boiler shop, the erecting bay being covered by a 30 ton crane, with tracks 24 ft. 2 ins. above the floor, and the boiler machine bay by two 10 ton cranes, with tracks 20 ft. above the floor. The runways for the 30 ton crane are 3 ft. plate girders located for a crane span of 47 ft. 10¼ ins. between centers, and for the 10 ton cranes 2 ft. plate girder runways are used, located 43 ft. 10¼ ins. between centers and supported by structural bracket construction. For the 30 ton crane rails weighing 80 lbs. to the yard are used, and for the 10 ton crane rails weighing 60 lbs. to the yard. The cranes were built by the Shaw Electric Crane Company, Muskegon, Mich., who also supplied the cranes used in the erecting and machine shop building. In general, all the cranes used at the shops, except those in power house, were built by the Shaw Electric Crane Company, and furnished by Manning, Maxwell & Moore, New York.

Another interesting feature of this building is the pipe tunnel and drainage system in the erecting bay. The details

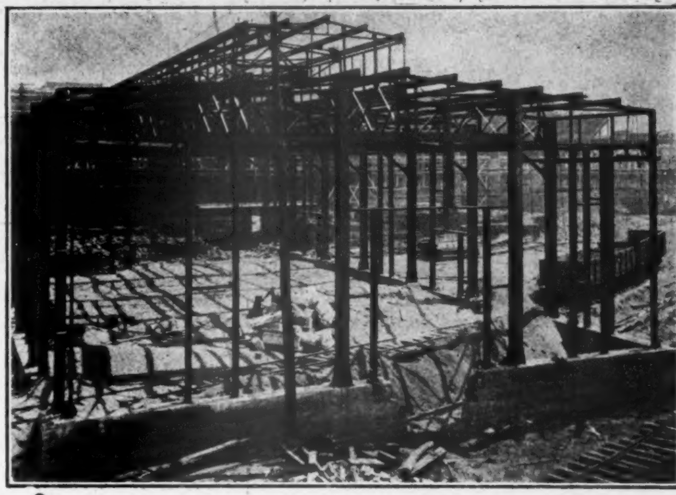
No. 12 in the erecting shop; this affords a convenient means of transferring forgings to the machine shop and also facilitates the handling of frames to and from the smith shop.

The blacksmith shop building is 201 ft. 9 ins. long and 77 ft. 9 ins. wide outside, and 189 by 74 ft. inside the walls. The longitudinal track is not located in the center of the building, being set 8 ft. to the west of the center line; this arrangement permits a better division of the work. The forge fires, of which there are ten double forges of a new and novel design, are located on the east side of the building, as indicated by the inclined rectangles; this inclined arrangement provides much more room for the handling of pieces in the fires and is much more convenient for the workmen.

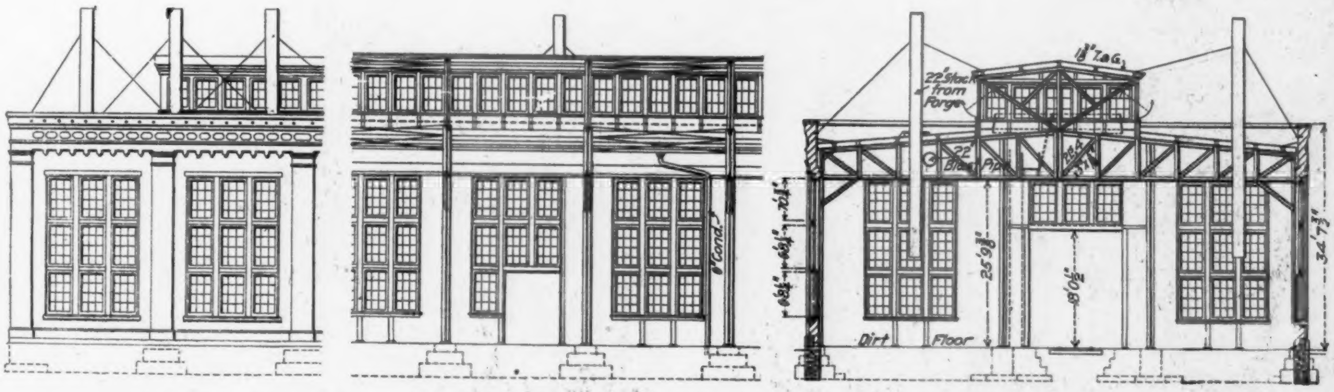
The steel work of this building was rendered simple by the use of the single span permitted by the width of 74 ft. The roof, which is of the monitor type, is carried by simple trusses, which are spaced at intervals of 22 ft. throughout the length of the building. The details of the steel construction, as well as of the monitor, are made clear in the cross section and elevation views. The roof construction and covering is similar to that used upon the boiler shop. Liberal provision for ventilation is provided by this monitor arrangement, the side windows of which can be operated from the floor, so that, with the side windows, any desired combination of openings for draft may be made to clear the shop of smoke; walkways are provided on either side of the monitor for access to the windows for

cleaning, etc. Inside roof drainage is provided in this building also.

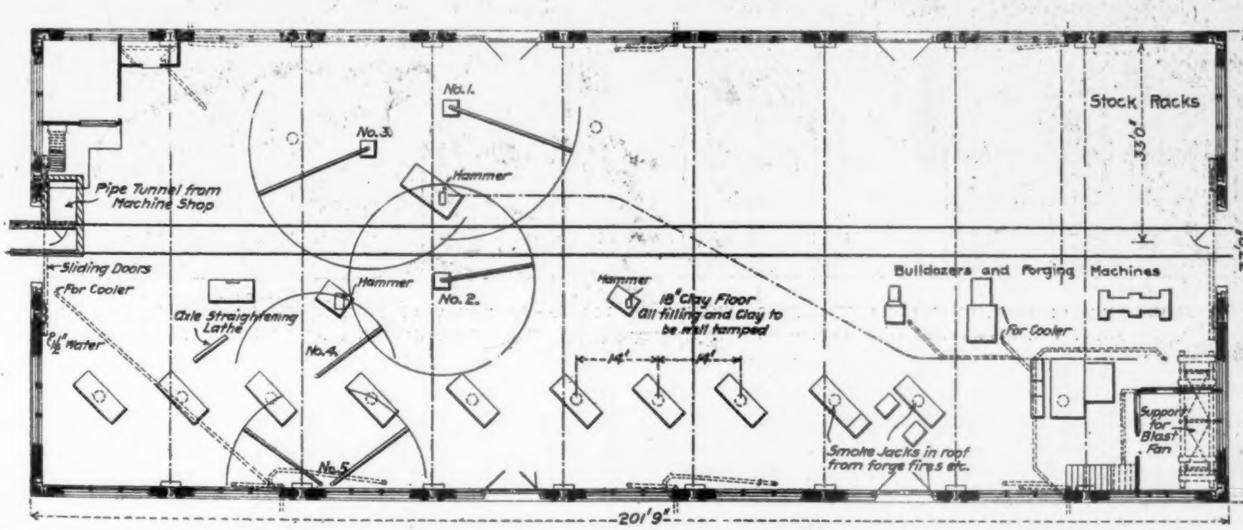
The floor in the blacksmith shop is a clay floor throughout. It is composed of a filling well tamped, and a covering of 18 ins. of clay, which is also tamped solid, thus making a very substantial floor. Ample drainage is provided. The pipe tunnel supplying this building does not extend through; it enters from the machine shop beneath the connecting track and ends just inside the south wall of the building. From that point the piping is carried overhead. The arrangement of apparatus upon the floor is indicated upon the plan drawing. The forge fires extend along the east side of the building, while in the center, and within the radii of the jib cranes, are the steam hammers for heavy forging. At the north end is located the blast fan equipment and the bulldozers and forging machines, on one side, and the stock racks on the other side of the track; in the southwest corner is located the foreman's office. The curved dotted line near the middle indicates the location of a trolley hoist that will be installed for handling material and heavy pieces.



CONSTRUCTION VIEW OF THE BLACKSMITH SHOP BUILDING.



PART ELEVATION AND PART LONGITUDINAL SECTION, AND CROSS-SECTION OF THE BLACKSMITH SHOP BUILDING.



PLAN OF THE BLACKSMITH SHOP BUILDING, SHOWING ARRANGEMENT OF THE FORGES, STEAM HAMMERS, ETC.

NEW McKEES ROCKS LOCOMOTIVE SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

The crane facilities provided in this building are jib cranes, the locations of which are shown on the plan at Nos. 1 to 5, crane No. 5 being a double jib crane. The hammers are thus served in a most complete manner and crane No. 5 serves two of the forge fires for heavy work. Especial provision was made for the jib cranes in the roof steel work; each crane has a heavy concrete foundation and has its top bearing in a heavy gusset specially arranged on the lower side of the roof trusses, in line above the foundation bearing. These cranes are all operated by hand, having been supplied by the Whiting Foundry Equipment Company of Harvey, Ill. Other interesting features of this shop will be presented in a later article.

(*To be Continued.*)

A subscriber writes us as follows in renewing his subscription: "I am much pleased with the AMERICAN ENGINEER AND RAILROAD JOURNAL. It fills the bill completely. I desire to say that I agree with your estimate of Mr. W. O. Thompson's paper on 'The Apprentice Question' on page 436 of the December issue. He takes a very common sense view, especially is the point of contact between the foreman and the apprentice well taken."

Germany desires to enter four locomotives for testing on the Pennsylvania Railroad testing plant at the St. Louis Exposition next year. Three of those which are offered are equipped with superheaters.

A NOVEL DESIGN OF ELECTRICALLY-DRIVEN MILLING MACHINE.

WITH DETACHABLE CLUTCH DRIVE.

That a satisfactory solution has been made of the difficulties met with in the problem of designing a successful arrangement for motor driving on a milling machine is evident from a study of the accompanying engravings. This problem has been found quite complex because of the peculiar service to which milling machines are put. The principal points to be considered in the design of such an arrangement are:

(a) the wide range and great number of speeds that are now a necessity for economical milling;

(b) the large amount of power consumed, which requires a motor that is very large as compared to the size of the machine;

(c) the fact of the large number of times a milling machine must be started and stopped in a day.

That these conditions have been thoroughly provided for in this design may be seen from the illustrations, which show a No. 4 plain Cincinnati miller, with motor drive, which was recently brought out by the Cincinnati Milling Machine Company, Cincinnati, O. This is by no means an experiment, but is the result of over four years of careful study of the problem of electric driving as applied to millers. A number of this company's smaller machines on which a similar arrangement is used, are now in successful operation in this country and in Europe.

The design of this machine is based on the conclusion, which is now very general, that the only satisfactory arrangement of a direct connected electric drive for machine tools is obtained by the use of some type of variable speed motor; and in this particular case the builders strongly advocate the use of a shunt-wound direct-current motor arranged for variable speeds by field control. The variation in speeds being obtained from the motor, obviates the use of the usual mass of gearing; and the field rheostat has the advantage that when once set to give the desired speed for a particular job, it need not be disturbed when again starting the machine or motor, and thus eliminates the trouble that arises from setting the lever to the wrong notch, as may happen when the street car type of controller is used.

Reference to Fig. 2 shows the manner in which the motor is mounted on an extension which is cast to, and forms part of, the base of the machine. This brings it near the floor, thereby adding to the stability of the machine, and as the entire motor arrangement is at the rear, it occupies space which would not be available for other purposes because it much be kept free to accommodate the table travel.

Any one of several well known makes of motor can be used with this arrangement, providing it is shunt-wound and is capable of a speed variation of 2½ to 1. This range is multiplied by the double back gears, giving at the spindle a range of speeds suitable for cutters of 5-16-in. to 6 ins. in diameter at a surface speed of 20 ft. per minute, and for cutters from ⅝-in. to 12 ins. in diameter at a surface speed of 40 ft. per minute, for use with cast iron. It is, of course, evident that such a machine fitted with a shunt-wound motor is thoroughly adaptable for installation in shops employing the multiple voltage system, in which case the motor need only be arranged for that system.

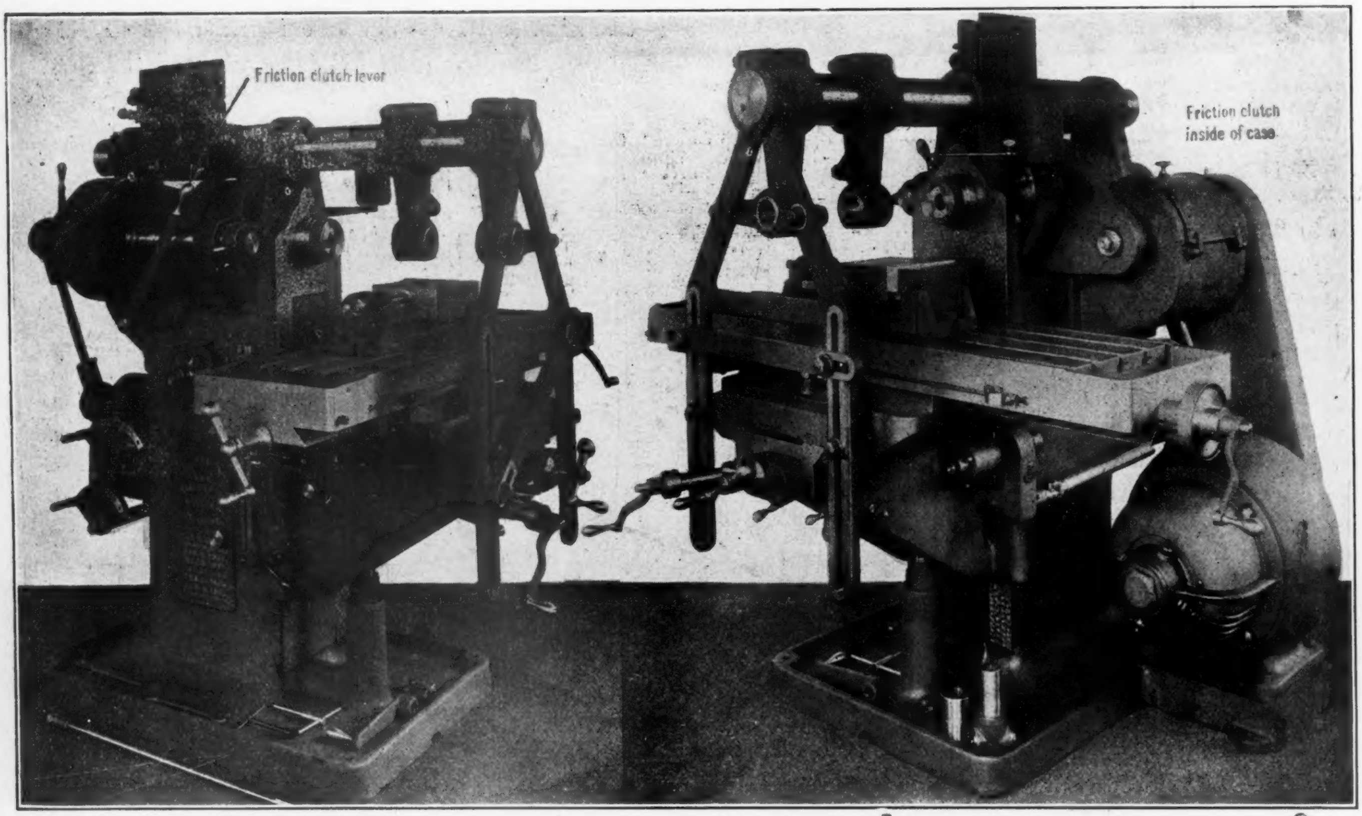


FIG. 1.—FRONT VIEW OF TOOL, SHOWING CONVENIENT ARRANGEMENT FOR OPERATING HANDLES.

FIG. 2.—REAR VIEW OF TOOL, SHOWING ARRANGEMENT OF MOTOR AND FRICTION CLUTCH FOR THE DRIVE.

NEW DESIGN OF MOTOR DRIVING.—CINCINNATI MILLING MACHINE COMPANY.

Power is transmitted from the motor to the spindle through, first, a friction clutch, and then by a Morse silent chain. This interposition of the friction clutch between the motor and spindle, is the most novel feature of the design. By means of it the machine may be started and stopped quickly without stopping the motor, thereby saving that considerable amount of time that would otherwise be lost in waiting for the motor to come to a stop, and, when starting, in waiting for the motor to come up to speed. This is an item that is usually overlooked. It amounts to a great deal as compared to the cost of running the motor alone while the machine is making short stops for chucking work. The motor can, of course, be stopped at any time by cutting off the current in the usual way.

Fig. 1 shows the arrangement of the automatic no-load-release starting box, the field rheostat, the friction clutch lever, the back gear lever, and the double back gear, as well as all feed-changing and adjusting levers at the front of the machine, within easy reach of the operator, who need never go to the rear of the machine except for oiling.

Fig. 3, a sectional plan through the spindle, shows the arrangement of the double back gears and the details of construction of the clutch drive. The chain from the motor drives the wheel A, which transmits power through the friction clutch to shaft B; shaft B drives through a chain, and chain wheels C and D, to the main spindle, E.

The back gears F and H are both keyed onto a sleeve I, which is arranged to revolve with and slide on back gear quill J; when used in the position shown in Fig. 3, back gear, F, is driven by the smaller gear, P, on the main driving quill, K, on the spindle, which gives the first series, or slow, back gear speeds. When it is desired to use the second back gear, or faster speeds, the gears are thrown out of mesh in the usual way, the sleeve is merely pulled along the back gear quill to

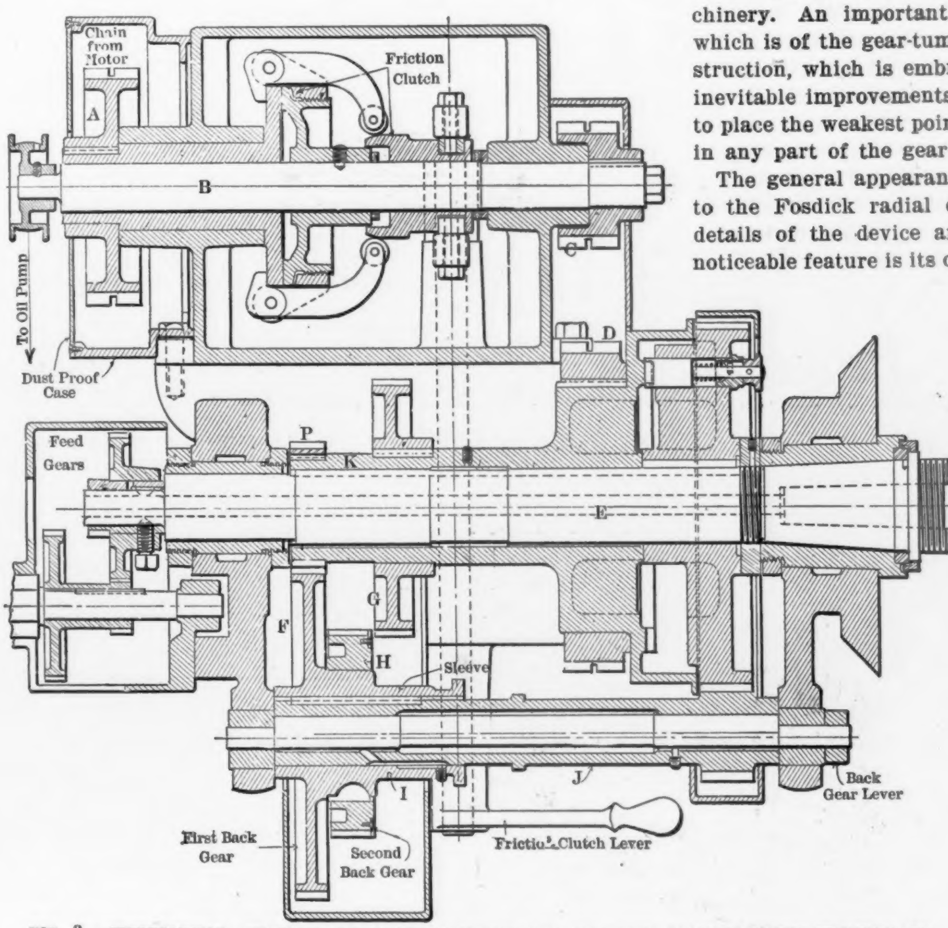


FIG. 3.—HORIZONTAL SECTION THROUGH SPINDLE OF THE NEW MOTOR-DRIVEN CINCINNATI MILLER, SHOWING DETAILS OF CLUTCH, DOUBLE BACK-GEARS, ETC.

bring gears, H and G, in line, and then the back gear again thrown in. The gear, H, is provided with a flange, so that there is no possibility of this gear sliding into mesh with gear G when the other pair are in mesh.

The friction clutch lever gives the operator as complete, and a very much more convenient control of the spindle, than he has when driving from a countershaft in the usual way, and it is also convenient for throwing partially in to make a partial revolution of the spindle, the advantage of which is at once apparent to one used to operating machine tools.

The Cincinnati Milling Machine Company who are prepared to supply any of their back geared machines with this arrangement of driving, are to be congratulated upon this excellent design. It will mark an important advance in motor driving and its success seems to be assured.

The directors of the Midland Railway of England have appointed Mr. Richard Mountford Deeley, locomotive works manager at Derby, to be chief locomotive superintendent to succeed Mr. S. W. Johnson, who is retiring. Mr. Deeley recently visited the United States to inquire into the engineering methods on American railways.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XII.

BY C. W. OBERT.

A novel and interesting design of variable-speed geared driving mechanism has recently been developed by the Fosdick Machine Tool Company, Cincinnati, Ohio, which is a departure from former practice along this line and which embraces important improvements. It was designed for use as the main drive of the Fosdick radial drill, in place of the cone pulley and belt drive, in order to give the wide range of driving speeds which are so necessary for the best results with drilling machinery. An important feature of this driving mechanism, which is of the gear-tumbler type, is the especially strong construction, which is embraced in the design to provide for the inevitable improvements in the tool steel; the desire has been to place the weakest point in the main driving belt, rather than in any part of the gear mechanism.

The general appearance of this mechanism, as it is applied to the Fosdick radial drill, is shown in Fig. 54, while the details of the device are made clear in Fig. 55. The most noticeable feature is its compactness; it requires even less room than did the cone pulley which it has replaced, and no change of design of other portions of the drill have been made necessary. The most important feature of this speed mechanism is that it is so arranged that, no matter what speed the machine is to be run at, the driving gear is always started up at a slow speed at first, a special initial-speed attachment being arranged to permit the inertia of the gears and shaft to be overcome and to prevent the strain that might be caused by throwing in the shifting gears suddenly on a high-speed.

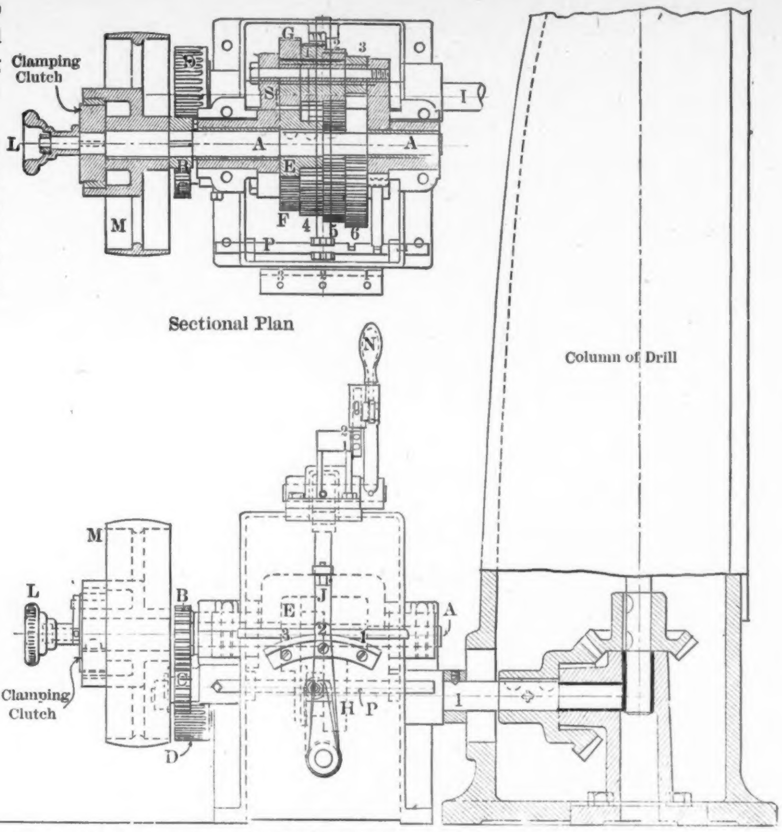
The drive for the mechanism is received on belt pulley, M, (see Fig. 55) which is located on shaft, A, the main driving shaft of the mechanism. Upon this shaft is keyed a gear, E, within the box, which drives two cones of gears with which it meshes, each of which gear cones is carried at one of the forked ends of the rocker frame, S; this construction is made clear in the end view, with pulley M, removed (Fig. 55) which shows the rocker set with cone, G, in mesh with the driven gear, H. In this way, cones of gears, F and G, always revolve with shaft, A, and it is only necessary to shift rocker frame, S, by handle, N, after having moved gear, H, along to the proper position by handle, J.

The gear, H, which operates the drive to the drill directly, is splined to the shaft, I, and is moved along by fork, K, which is operated by handle, J. To prevent accident from careless handling, the movements of handle J are interlocked with those of handle N, so that J can not be moved unless N is in a central position and thus both cones, F and G, are lifted out of mesh with gear H.

In starting up the mechanism, however, the rocker, or tumbler, frame is merely thrown to the proper position and the gears mesh accurately at once; no shock is given the drill by abruptly throwing over the handle, as the initial self-acting speed clutch, previously referred to, has already brought shaft, I, into motion, but nevertheless, as soon as one of the cone gears commences to drive gear, H, it releases automatically from shaft, I. This is accomplished by a special design of automatic clutch contained within gear, D. Gear, D, is always

driven through pinions, B and C, from the driving shaft, so that whenever the gear cones are thrown out of action and shaft, I, slows down, the clutch in D acts and keeps it moving at a slow speed. This is an important and very effective feature, and it is a scheme that works excellently in practice.

Shaft, A, is driven from pulley, M, through an interesting clamping clutch which permits the drive to be started and stopped with the utmost facility. This clutch is located within the hub of the pulley and is operated by merely turning hand wheel, L. When shaft A is at rest it is merely necessary to turn wheel, L, to the right and the drive starts instantly; when



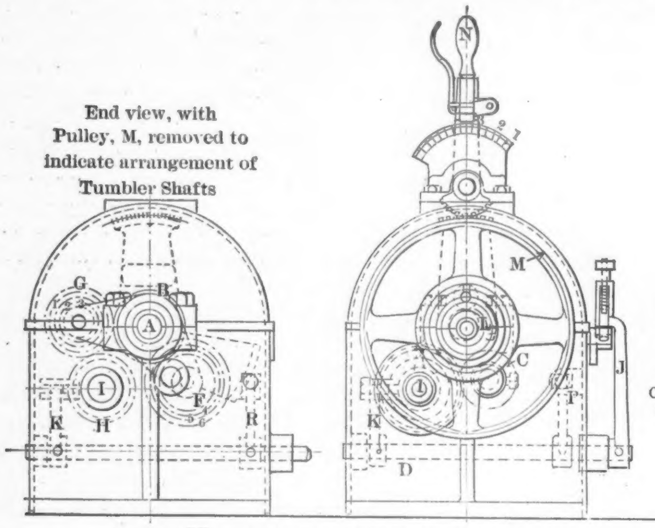


FIG. 55.—DETAIL DRAWINGS OF THE VARIABLE-SPEED DRIVING MECHANISM UPON THE FOSDICK RADIAL DRILL.

FIG. 54.—VIEW OF THE 6-FT. FOSDICK RADIAL DRILL AS EQUIPPED WITH THE NEW VARIABLE-SPEED GEARED DRIVING MECHANISM—FOSDICK MACHINE TOOL COMPANY.

the drive is in motion, it is only necessary to slightly retard wheel L and the clutch releases at once. This is another important factor of the drive, as it not only eliminates the necessity of the belt shifter, but also is infinitely quicker and easier to operate.

Both handles, J and N, have index plates with numbered positions in which they may be set for the different speed combinations of which there are six. These combinations are indicated on an engraved index plate which is attached to the box. The changes are easily made and require no thought or effort. These six speeds available at the speed box, taken in conjunction with the three additional speeds provided by the back gear on the arm, make 18 changes of speed possible at the drill spindle, all of which are calculated for the best results with the various sizes of drills.

PERSONALS.

Mr. B. R. Moore, the mechanical engineer of the Chicago, St. Paul, Minneapolis & Omaha Railway, has been appointed assistant superintendent of motive power and machinery, with headquarters at Sioux City, vice F. M. Dean, resigned.

Joseph Stehlin has been appointed mechanical engineer of the New York Central & Hudson River, with headquarters at New York, succeeding A. J. Slade, resigned. Mr. Stehlin will report to E. B. Katte, electrical engineer, on designing and construction of power stations except those in the electric traction system, and to Olaf Hoff, engineer of structures, on designing and installation of heating and lighting plants, water and coaling stations.

Mr. H. F. J. Porter who has been associated with Westinghouse interests since the first of the year and has held the position of assistant manager of the Publishing Department, has been made second vice-president of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is president. His duties will be that of general manager and his headquarters will be at Pittsburg. He assumed charge on December 1. This appointment does not, however, affect Mr. Porter's present relations with the Publishing Department at this time.

THE PENNSYLVANIA RAILROAD LOCOMOTIVE TESTING PLANT FOR THE ST. LOUIS EXPOSITION.

FIRST BULLETIN OF ANNOUNCEMENT.

In our July, 1903, issue, brief mention was made of the locomotive testing laboratory of the Pennsylvania Railroad, which is being constructed for permanent installation at Altoona, Pa., but which will be temporarily erected at the Louisiana Purchase Exposition as a part of the exhibit of the road. The Pennsylvania Railroad has now issued a bulletin which describes very fully the work that will be carried out, referring to the organization and to the plan and scope of the work. The history of the organization of the Advisory Committee is given in detail in the introduction, together with copies of the letter addressed to the Master Mechanics' Association and to the American Society of Mechanical Engineers, and also the resolutions passed by both of these bodies in accepting the invitation to participate in the tests.

The organization of the work is as follows:

For the Pennsylvania Railroad System:

J. J. Turner, third vice-president, Pennsylvania lines west of Pittsburg.

Theo. N. Ely, chief of motive power, Pennsylvania Railroad System.

F. D. Casanave, special agent, Pennsylvania Railroad System.

E. D. Nelson, engineer of tests, Pennsylvania Railroad Company, Altoona, Pa.

For the Louisiana Purchase Exposition:

Williard A. Smith, chief of the Department of Transportation Exhibits, Louisiana Purchase Exposition.

Advisory Committee: On Behalf of the American Society of Mechanical Engineers:

W. F. M. Goss, dean of the Schools of Engineering, Purdue University.

Edwin M. Herr, general manager, Westinghouse Air Brake Company.

J. E. Sague, mechanical engineer, American Locomotive Company.

On Behalf of the American Railway Master Mechanics Association:

F. H. Clark, superintendent of motive power, Chicago, Burlington & Quincy Railroad.

C. H. Quereau, superintendent of shops, New York Central & Hudson River Railroad.

H. H. Vaughan, assistant superintendent of motive power, Lake Shore & Michigan Southern Railway.

Officers:

F. D. Casanave, special agent of the Pennsylvania Railroad System.

(W. F. M. Goss, chairman of the Advisory Committee.)

(H. H. Vaughan, secretary of the Advisory Committee.)

These officers were elected at a formal meeting of the joint committees at the annual conventions of both societies at Saratoga in June. The committee has held a number of meetings and formulated complete plans for carrying out the tests. This first bulletin gives the plan and scope of the work in such an accurate and complete manner that it is printed in full below. Further bulletins issued from time to time will give the results of the work as it is being carried on.

PLAN AND SCOPE.

The Pennsylvania Railroad will design and cause to be constructed a suitable plant for testing locomotives, and, in co-operation with the Department of Transportation Exhibits, will install the same at St. Louis. The plant will be ready for perliminary running by the first of March next, and in perfect running condition by the first of May, at which time formal work will commence. The purpose of the whole work is to be comprehensive, and the endeavor will be to determine by the use of locomotives presenting different characteristics, the effect of the latter upon the economic performance, and the limits of the tractive power and boiler capacities.

The Pennsylvania Railroad system will organize and maintain, under the direction of its Engineer of Tests, a staff of laboratory attendants and computors, to the end that the plant and the locomotives thereon may be safely and properly operated and the experimental data promptly handled. It will also provide supplies of fuel and oil, and will meet all other fixed charges incident to the progress of the work.

The Pennsylvania Railroad, having called to its aid an Advisory Committee to assist in all matters of scientific interest, will in consultation with this Committee make selection of locomotives to be tested, determine conditions under which tests are to be run, specify as to the observations to be taken and the methods to be employed, and determine the manner in which the data shall be handled and the form in which the final results shall be presented.

THE ADVISORY COMMITTEE. While the communication of the Pennsylvania Railroad, in response to which the members of this committee were appointed, clearly contemplates additions to the membership of the committee, those already appointed have organized, and have been required to act in formulating the provisions of this program. To avoid confusion, therefore, those already appointed will be regarded as "Members" of the Advisory Committee. Foreign representatives and others who may be hereafter appointed will be designated as "Affiliated Members." Members and Affiliated Members of the Advisory Committee shall have voice and vote alike.

The Advisory Committee will devote such time as may be necessary to the general plan of the work, and may be called together at any time by the Chairman, or by an authorized representative of the Pennsylvania Railroad.

THE TESTING PLANT. The details of this plant are now being worked up by the Pennsylvania Railroad. It is to consist of supporting wheels upon which will be carried the drivers of the locomotives to be tested, with friction brakes on the shafts of the same, a registering dynamometer of 80,000 lbs. capacity, to which the drawbar of the locomotive will be attached, together with all necessary accessory apparatus for operating the plant and obtaining the desired data therefrom. As soon as practicable it is intended to issue a bulletin which shall completely describe and illustrate the details of the plant.

LOCOMOTIVES TO BE TESTED. In selecting locomotives for test, an endeavor will be made to secure variety in the essential principles of design. Since the time is necessarily limited, no considerable attention will be given in attempts to analyze the action of minor details. On the contrary, the effort will be to establish the economic performance of a number of typical locomotives when operating under a wide range of conditions.

No locomotive or type of locomotives will be acceptable, the value of which has not been proven by successful service on the road.

Locomotives to be acceptable must have weight and power which will make them comparable in these respects with the modern American machine. It is proposed to test no locomotive which has less than 2,000 ft. of heating surface in its boiler, excepting that in case of locomotives having superheaters the superheating surface may be regarded as heating surface, and in the case of locomotives having Serve tubes, credit for the surface of the ribbing will be allowed.

The gauge of the supporting wheels will be 4 ft. 8½ in., or the same as the standard gauge of American railroads, and the gauge of the locomotive offered for test must be such as to run safely thereon.

It is planned to test twelve different locomotives, and it is hoped that a portion of this number can be of foreign design and construction. The time to be allowed to each locomotive will vary from 20 to 14 working days, the longer time being allowed those which are tested early in the season when both men and equipment will be new to the work. The intervals proposed are as follows:

1904.

1. May 2 to May 23, inclusive.
2. May 24 to June 13, inclusive.
3. June 14 to July 1, inclusive.
4. July 2 to July 19, inclusive.
5. July 20 to August 5, inclusive.
6. August 6 to August 22, inclusive.
7. August 23 to September 7, inclusive.
8. September 8 to September 23, inclusive.
9. September 24 to October 10, inclusive.
10. October 11 to October 26, inclusive.
11. October 27 to November 11, inclusive.
12. November 12 to November 30, inclusive.

It is not possible at this time to present a complete list of the locomotives which will be tested, but this is now under careful consideration, and will be announced in a later bulletin.

It is considered advisable that the owner of each locomotive presented for test should furnish a man thoroughly familiar with its working to look after the lubrication, and in general, render such

assistance as will insure the tests being run without interruption. The owner should also, if found necessary, provide a man thoroughly familiar with the mechanical details of the locomotive, who can advise in regard to any repairs that may be necessary during the series of tests.

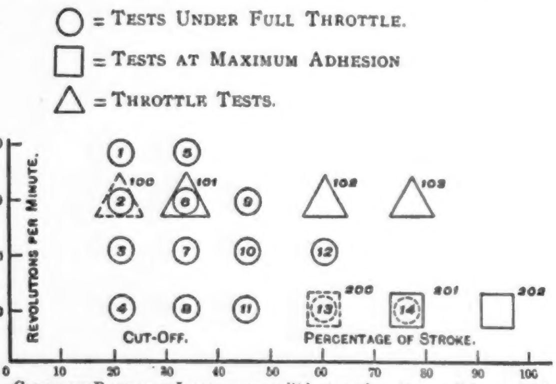
FUEL. The Pennsylvania Railroad Company will supply for all participants, two grades of coal of high quality, one an anthracite and the other a bituminous. The quality of each of these grades will remain unchanged throughout the progress of the work. This composition will be approximately as follows:

	Anthracite, per cent.	Bituminous, per cent.
Volatile matter, including water......	8	20 to 22
Fixed carbon	86	69 to 74
Ash	6	9 to 6

FIREMEN. The Pennsylvania Railway will supply men whose experience on the road will have been supplemented by special training for their work upon the testing plan. Unless otherwise arranged, these men will fire all locomotives under test. Exhibitors may, however, furnish one of their own men to give necessary instructions to the regular firemen.

THE TESTS. It is proposed to make from 16 to 20 formal tests of each locomotive put upon the plant, these to be preceded by one or more preliminary runs for the purpose of checking the valve setting, and of proving all accessory apparatus.

Each formal test will involve a run of approximately 100 miles, and throughout its duration the speed, load, steam pressure and other conditions of running will be maintained as nearly as possible, constant. The conditions represented by the several tests upon each locomotive will be so chosen that the results will fall into sets, and when so plotted will serve to disclose the performance of the locomotive under the full range of speed and cut-off for which it can be properly worked. The conditions which have been chosen for the formal tests are set forth diagrammatically by Figs. 1 and 2.



COMPOUND PASSENGER LOCOMOTIVES will be tested under conditions which are comparable with those specified for simple locomotives.

Fig. 1—Simple Passenger Locomotives.

Referring especially to Fig. 1, the circles show the speed and cut-off at which it is proposed to run the tests under a fully open throttle. Tests 1 to 4 represent a set at constant cut-off under speeds varying from 80 to 320 revolutions, the cut-off for these tests to be about 20 per cent. of the stroke. All tests of this set will be well within the capacity of the locomotive. Tests 5 to 8, inclusive, represent a second set, the cut-off for which will be made such as to make the power for test 5, the highest which can be developed at a speed of 320 revolutions. A third set at longer cut-off is made up of 9, 10 and 11. In this case the cut-off of the set is to be made such that No. 9 will give the maximum power which can be developed at a speed of 240 revolutions. Similarly, test 12 is to be made at such a cut-off as to demand the full power of the boiler at a speed of 160 revolutions, and with it will be grouped test No. 13, provided the adhesion of the drivers will permit a fully open throttle under so long a cut-off.

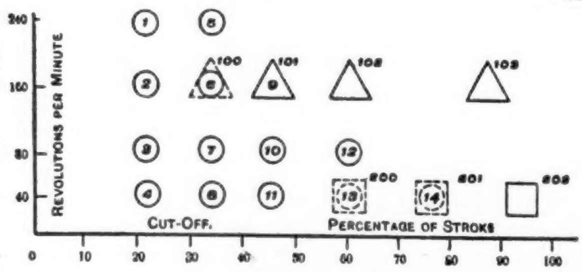
In case test 13 can be run, then another at a still longer cut-off, as, for example, test 14 at a speed of 80 revolutions, will be attempted. It will be apparent that tests under conditions thus chosen cover the entire range under which the locomotive may be operated with the throttle wide open. Thus, at any particular speed, an attempt to use the longer cut-off would result in a failure of the boiler to supply steam, or possibly, at the lowest speed, in the slippage of drivers. Similarly, at any particular cut-off, an attempt to operate at a higher speed would result in a failure of the boiler to supply steam. By combining the results the effect of either changes in speed or changes in cut-off in the performance of the locomotive can be readily shown.

To determine the performance of the locomotive under varying throttle openings the series 100, 101, 102 and 103 will be run. This series will be at a constant speed. The power for all tests and, consequently, the drawbar pull will be constant, and will be the same as that developed under a wide open throttle in test 2. For test 101 the cut-off is lengthened and the throttle closed sufficient to make the power the same as when with the shorter cut-off the throttle was wide open. Test 102 is at a still longer cut-off, for which the throttle will be still further closed, and test 103, the longest cut-off and the throttle of the least opening for the series. It is evident that the results of this series will show the relative performance of the locomotive in doing a given amount of work under a varying degree of throttling.

Tests 200, 201 and 202 are under starting conditions. The speed of all is to be the same. For test 202 the reverse lever is to be in its extreme forward position, and the throttle opening as wide as can be allowed without danger of slipping the drivers. Test 201 is with a shorter cut-off and wider opened throttle, and test 200 with a full open throttle.

It should be evident from the explanation which has been given that the diagrams Figs. 1 and 2 do not attempt to show the actual cut-offs which will be experimented upon, nor the precise number of tests which will be necessary to define the performance of a locomotive, but rather the principles which will underlie the selection of conditions, and the relation which the several tests bear each other. The limits of performance will be different for different locomotives, and one of the tests will be to establish values for these limits.

The several speeds employed for all passenger locomotives will be those set forth in Fig. 1, so that the data for the several different locomotives will be strictly comparable.



COMPOUND FREIGHT LOCOMOTIVES will be tested under conditions which are comparable with those specified for simple locomotives.

Fig. 2—Simple Freight Locomotives.

The conditions under which freight locomotives will be tested will involve the several speeds given in Fig. 2. A comparison will show that while the range of speed for the freight locomotive is lower than that fixed for the passenger locomotive, the two sets of conditions supply ample opportunity for the inter-comparison of results which may be obtained from the two classes of locomotives.

The conditions specified for testing compound locomotives are necessarily more general than those with reference to simple locomotives, since it does not appear that any single diagram can be made which will serve to define the conditions of running with reference to compounds. For example, some of the compounds submitted for test may be of such design that a single movement of the reverse lever will change the cut-off in both the high-pressure and low-pressure cylinder (or cylinders). Others may be so arranged that the cut-off remains constant on the low-pressure cylinder until after that upon the high-pressure cylinder has been reduced to half stroke, and still others may have the control of the high-pressure cut-off quite independent of that of the low-pressure cut-off. No simple statement as to cut-off, or even as to number of expansions, will have the same force when applied to locomotives of these different types. Again, some of the locomotives may have no provision for using high-pressure steam in the low-pressure cylinder, while others may be equipped with a by-pass for use at low speed. Obviously, machines thus designed should be tested with the by-pass in use, as well as without it.

In view of these facts, it seems wise in case of compound locomotives, to reserve a specific statement of the conditions which are to prevail until the characteristics of each locomotive to be tested are known. The conditions which will then be proposed will be submitted to each exhibitor interested, for criticism, and finally for approval.

In the meantime, it can be said that compound locomotives will be tested under conditions which are comparable with those specified for simple locomotives. The speeds will be the same and the several tests for each speed will be under such conditions of cut-off as will

disclose the performance of the locomotives under a similar range of action. The conditions to be specified for each compound locomotive will have due regard for peculiarities in its design, to the end that the power and efficiency of each machine may be demonstrated under all conditions of running which may have been contemplated in its design.

METHODS TO BE FOLLOWED IN RUNNING A TEST. In preparation for a test, the locomotive will be started and gradually brought to the conditions of running which are to prevail throughout the test. When these conditions have been secured the preliminary running of the locomotive will be continued until the rate of firing becomes uniform and until all portions of the locomotive have become warmed to their work. When these conditions have been secured two strokes of a bell will give a preparatory signal. Thirty seconds later a single stroke of the bell will mark the beginning of the test. Upon this stroke all water levels will be observed, the ash pan cleaned and all observations taken, and thereafter all water and fuel used will be taken from a weighed supply. Throughout the test all conditions of running will be maintained as nearly constant as possible, observations being taken on the stroke of the gong at ten minute intervals. The duration of the test will vary from two to six hours, depending upon the rate of speed and load. The element of control in fixing the length of the heavy power test will be the amount of water evaporated, no test being ended until the evaporation equals 30 lbs. for each square foot of heating surface. The lighter power tests may end after from four to six hours.

A test will be ended as it began. The fire which, throughout the test will have not changed greatly in its condition, will be brought as nearly as possible to the condition it had in the beginning, the ash pan will be cleaned, the water level in the boiler will be made to agree with that of the beginning of the test, and upon signal the final observations will be taken, and the use of water and fuel from a weighed supply will cease. As soon as practicable after this the locomotive will be stopped, the front end cleaned, and the data of the test collected and made of record.

A test will be started not earlier than 8 o'clock on each day, and when the conditions are such as will permit them to be of short duration, two tests may be run on the same day.

To avoid chances for error all important observations will be taken in duplicate by the use of independent instruments and observers. For example, the feed water will be metered and afterwards weighed, the weighings constituting the real record, and the readings of the meter the check record. The speed will be indicated by a Boyer or other speed indicator, and also by a counter which will register the revolutions, the latter supplying the real record, and the former the check record. Pressures will be observed from dial gauges, and registered by a Bristol recording gauge, the observed pressures constituting the real record; the recorded pressures the check. An indicator will be used on each end of each cylinder.

The smoke discharge above the locomotive will be so arranged as to entrap all solid matter or "sparks" passing out of the top of the stack. A chemical analysis will be made of the coal employed for each test, and of the smoke-box gases.

In the case of locomotives designed with special reference to the balancing of reciprocating parts, and in the case of others, the performance of which may contrast with them, an effort will be made to study the motion (rocking, nosing, etc.) of the locomotive as a whole while running at speed, in the hope that a definite relation will be found between the motion of the locomotive and its condition of balance.

In the case, also, of certain locomotives which will be selected with reference to their type of boiler, an effort will be made to secure a record of the direction and activity of the water currents circulating within several portions of the boiler when the latter is delivering steam, and especially of the cooler currents discharged from the injectors.

There will be obtained for each test, by direct observation, the following facts:

Position of reverse lever.
Position of throttle.
Revolutions per minute.
Total revolutions.
Pounds of coal fired.
Pounds of non-combustible material collected in ash pan.
Pounds of sparks passing out of the top of the stack.
Time when one or both injectors are in action.
Pounds of water weighed to injectors.
Pounds of water lost by injector overflow.
Record of calorimeter giving quality of steam in dome of boiler.
Indicator cards from each end of each cylinder, and from the valve box on one side.
Drawbar stress as shown by dynamometer.

Pressures as follows:
Of steam in boiler.
Of steam in branch pipe leading to cylinder.
Of air in the laboratory (barometric pressure).
Of air in ash pan.
Of gases in furnace.
Of gases in front-end.

Temperatures as follows:
Of the laboratory.
Of the feed water.
Of steam in branch pipe (for throttling tests only).
Of smoke-box gases.
Of water within the lower portions of the boiler at points systematically arranged.

CALCULATED OR OBSERVED RESULTS. The organization will be such as will allow the work of the computing room to keep pace with the development of observed data in the laboratory. The data will be presented in such form as will show the facts in three different relations.

1. The performance of the locomotive as a whole, under which relation general comparisons will be based upon the work developed at the drawbar.
2. The performance of the boiler.
3. The performance of the engines.

By having a separate presentation of the engine and of the boiler performance it will be possible to trace the effect of each modification in design, whether in the boiler or engine; that is, changes in boiler performance resulting from changes in proportions or forms, will readily be traced, and changes in engine performances resulting from difference in design can be accredited to their proper cause. Moreover, it will be possible in the final analysis of results to interchange the boilers and engines of different locomotives, and to predict with certainty the general results which would have been obtained from a locomotive made up of any such combination.

LOCOMOTIVE ACCESSORIES. Locomotives submitted for test must be equipped with such accessory apparatus as may be necessary for the attachments of all instruments of observation, so that there need be no delay in getting the locomotive into operation after it is received at St. Louis. Such accessory apparatus will consist chiefly of indicator plugs for cylinders and valve box, a water gauge glass for locating the height of water in the boiler, reducing motions for indicators, plugged openings into the boiler front-end, pipe connections which will serve in the attachments of gauges, thermometers and gas samplers, a light return crank for the attachment of a Boyer speed recorder and a registering counter, a drilled coupling pin hole in the foot plate, with a pin turned to fit, and provision for lubricating all journals when the locomotive is in motion. The exact character of each of these details will be made the subject of a later announcement.

PUBLICATION OF RESULTS. In order that the results may serve the largest purpose possible it is proposed to issue publications as follows:

1. Bulletins of Announcement. These will constitute the communications of the Pennsylvania Railroad and its Advisory Committee to the public, with reference to their plans and purposes. They will give information to those who may exhibit locomotives for test, and it is hoped that they will draw from those who are interested, such suggestions or criticisms as will assist in furthering its work.

2. Bulletins of Results. These will be issued from time to time, and will constitute formal reports of the performance of individual locomotives. It is expected that when tests upon a given locomotive have been completed, the results obtained, and such analysis of performance as may be based thereon, will be entirely set forth in a bulletin.

3. A formal publication to be issued at the conclusion of the whole work, presenting in such form as may be hereafter determined, the facts and conclusions developed by the whole study.

[Copies of this first Bulletin, and other information pertaining to the tests may be had upon application to F. D. Casanave, Special Agent, No. 910 Penn Square Building, Philadelphia, Pa.]

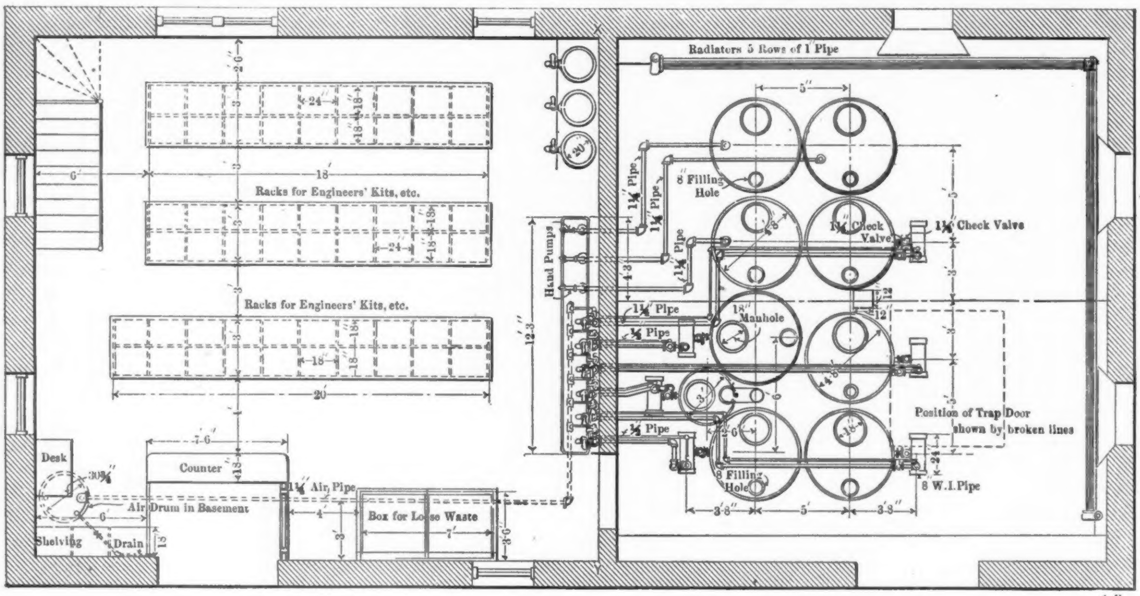
A contract for forty-eight 625-horse power water tube boilers has been awarded the Babcock & Wilcox Company by the New York Central & Hudson River Railroad, for installation in their new power stations, which will be used for generating power for the electric locomotive service, as noted in our last issue. The boilers will be of the Babcock & Wilcox forged-steel construction, designed to carry 200 lbs. working pressure, and will be equipped with the new patent superheaters of this company, proportioned to give a superheat of 200 degrees above the temperature of saturated steam at that pressure.

THE OIL HOUSE AT THE DU BOIS SHOPS.

Buffalo, Rochester & Pittsburgh Railway.

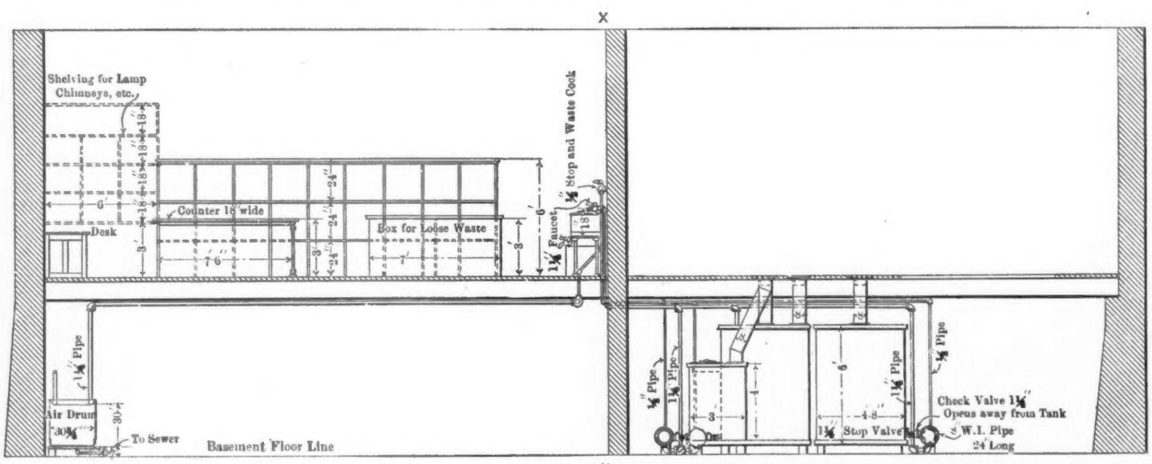
The plans for the oil house at the Du Bois shops of the Buffalo, Rochester & Pittsburg Railway, as indicated in these engravings, are the result of an extensive study of the practice of other railroads in the disposal of this important factor of the service. The description of these shops will be found in the April and May numbers of this journal for 1902.

The arrangement here shown permits of unloading oil and placing it in the storage tanks by gravity. The storage is in the basement of the building, the tanks having a capacity of 15 barrels each. Compressed air is used to raise the lubricating oils, while because of the possibility of some, if even slight, mixture with water from the air pipes, the coach, kerosene and signal oils are raised by pumps which are operated by hand at the delivery stand. In order to avoid placing the large tanks under air pressure, the oils which are raised by air are delivered by gravity into small reservoirs made of 8-in. wrought iron pipe, 2 ft. long. Check valves opening inward allow these small reservoirs to fill. When full, air pressure is admitted to them and the oil is forced to the outlet, the check valve in the pipe from the large tank closing against a return of the oil. Another check valve in the delivery pipe prevents the oil from running backward from this pipe and

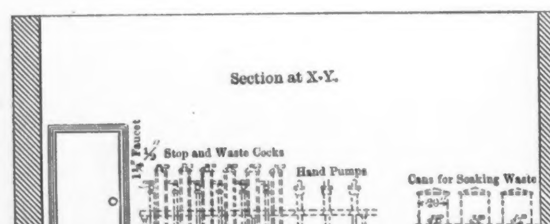


Plan of Ground Floor Plan of Basement

OIL HOUSE AT THE DU BOIS SHOPS. — BUFFALO, ROCHESTER & PITTSBURGH RAILWAY.



LONGITUDINAL SECTION OF OIL HOUSE. — DU BOIS SHOPS.



CROSS SECTION OF OIL HOUSE.

filling the small reservoir, which can be filled only by gravity from the large storage tank, when the pressure is off.

The tanks have 8-in. filling holes piped to openings in the floor above and each tank also has an 18-in. manhole. This building also furnishes storage for waste and lamp chimneys and contains lockers for the tools of the engine men. The size of the building is 60 by 30 ft., outside.

The extending use of aluminum for electrical purposes and the wide prospective use for it in the manufacture of thermit, makes the report that a St. Louis man has discovered a pyrochemical process of manufacturing aluminum from clay of considerable interest, especially so as he claims the metal will be greatly cheapened by the new process. The process, discovered by Mr. Schwahn, is claimed to effect the reduction in much shorter time than now required and to reduce the cost from $500 to $100 per ton.—*Machinery.*

WHAT ARE THE NEW MACHINE TOOLS TO BE?

BY JOHN E. SWEET.

(A Paper Read Before the American Society of Mechanical Engineers. New York Meeting, December 2, 1903.)

It is a fact quite apparent to users of machine tools (and first among them are the machine-tool builders themselves) that the new high-speed tool steel calls for a re-designing of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers. I think the machine-tool builders will admit that their machines must be re-designed; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say that everything has been all right, and all that we need to do is to change the strength and power. But have they been all right, or even half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross-girt plan in any form, and yet in the case of lathes, the whole business of whose beds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost in patterns and foundry work, and so, too, the tables which are sprung by bolting down work, can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry. The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which, with the springing by bolting down the work, are the primary causes of cut ways?

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends when fastened to the housings. The most of them are three sides of a box only, or one-tenth the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course, the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands, and then put the material in so that it will be four times more rigid, will be something like it. Housings of box sections will be just as rigid fore and aft, and much more rigid against side strain.

Milling machines of the planer style are constructed like planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load over-running the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the table because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle the pressure is always in the middle, first in one direction and then in the other, exactly the reverse from the gravity action, and instead of the side-guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and have to be refitted are never just right but when new and when so refitted. Where a short block slides on a long guide, if the scraper marks wear out sooner along the middle than at the ends, the ends of the guide need cutting off, however much over-run it gives to the sliding block.

The draughtsman dare not make a drawing of an engine crosshead over-running the guide one-third of its length at each end; the builder would hardly dare to build it if he did, and no user has the courage to take out the guides and cut them off or cut away the surface, even when he knows it would be money in his pocket, but *it is the thing to do.* We find that in the case of a slipper guide, owing to the effect of inertia and momentum giving a twisting action to the crosshead, it is necessary to cut away the guide so that the crosshead will over-run very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the crossheads over-running that way, and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders—this does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the results do not seem to justify the claim.

The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Sellers planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion, two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed around so as to properly mesh with a plain spur gear, or one with the teeth at such an angle as to skew the worm a little more, will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself.

If the designer will analyze every detail, he will find that many of the old features were not right to meet the old conditions and not half right for the new. While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which will do a variety of work will be still in demand for the sparsely settled sections of the country, and the colonies will call for the country machine shop as of old. It is the hope of the writer that this tirade will bring out an interesting discussion on machine-tool design and the capabilities of the high-speed steel, for that is the object of its presentation.

A CONVENIENT BOILER TESTER.

During a visit to the Du Bois shops of the Buffalo, Rochester & Pittsburg Railway, which were described in the April and May, 1902, issues of this journal, a convenient boiler testing injector was noticed in the shop. It consisted of an

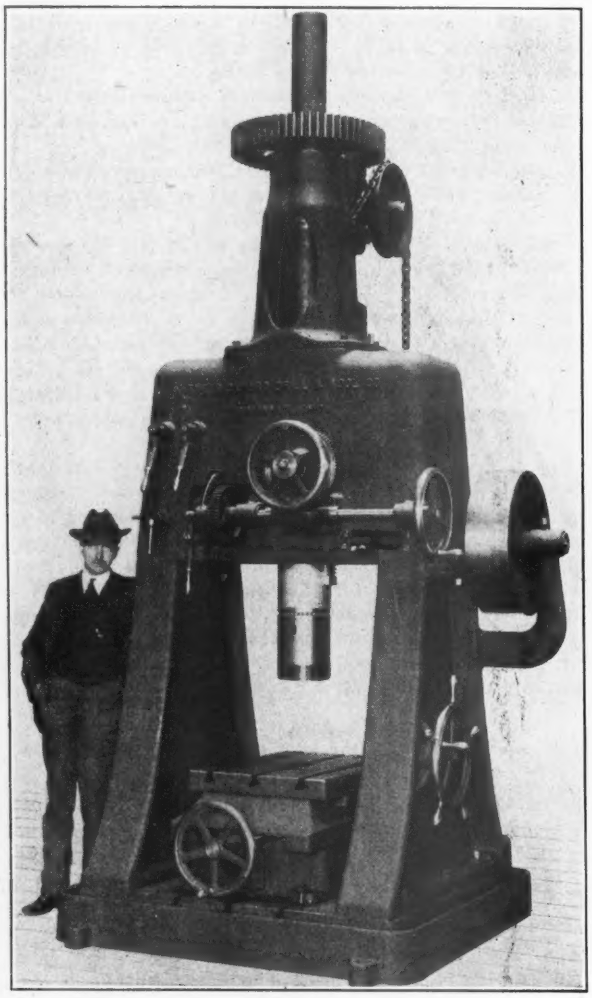
VIEW OF THE PORTABLE BOILER-TESTING INJECTOR.

injector permanently mounted on a framework of piping, as shown in the accompanying view, whereby it may be easily transported about the shop. The device in this form offers the advantage that the injector is located in an easily accessible position while in use. A number of these machines have been introduced into the shops of this road by Mr. C. E. Turner, superintendent of motive power.

A NEW 3-FT. TREPANNING MACHINE.

THE BICKFORD DRILL AND TOOL COMPANY.

We are pleased to learn that the Bickford Drill and Tool Company, Cincinnati, O., have recently completed another large trepanning machine for the Pennsylvania Railroad, which will be installed at the Altoona shops for service similar to that performed by its predecessor. This machine has been improved somewhat over the former trepanning machine which they built for the Altoona shops, but does not differ in principal details and dimensions; the more important change is



THE NEW BICKFORD TREPANNING MACHINE FOR THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

that of a larger number of feeds provided, giving double the number available in the former machine.

This tool is illustrated in the accompanying engraving. The particular advantage of this type of machine is that it performs the various operations of drilling, boring, facing, tapping and trepanning, under conditions as nearly ideal as it is possible to attain; the very heaviest operations can be handled in this tool with no fear of springing, or lack of rigidity. The head and cross rail are, as shown, made in one piece, so that the usual overhang of the spindle (which is the limitation of other forms of drilling machinery), is entirely eliminated.

The table of the tool is adjustable both transversely and longitudinally, and may be slid back out of the way when not needed, for which purpose an extension is cast on the base. The spindle has sixteen changes of speed, ranging in geometrical progression from 6 to 60 revolutions per minute, each of which is instantly available without having to shift a belt. It is also provided with both hand and power feed and quick advance and return. The driving mechanism is located on the back of the head and is operated by levers which project to the front of the machine, and, by being made to receive its power from a constant speed pulley, gives the greatest attainable economy of power. To obtain any one of the sixteen speeds with which the machine is provided, the operator has but to manipulate the levers, the proper position to give the correct speed for different metals and diameters of tools being shown by a table attached to the head.

The new feed mechanism provides sixteen feeds, ranging in geometrical progression from .01-in. to .25-in., instead of the eight provided on the former machine. The design of this mechanism does not differ however from that of the other, any feed being instantly obtainable by merely shifting two feed levers, which are conveniently placed on the front of the tool.

PRINCIPAL DIMENSIONS:

Diameter of spindle, least section	6 ins.
Spindle bored to fit P. R. R. taper	No. 8
Traverse of spindle	3 ft.
Maximum distance under spindle over base	4 ft.
Size of table, working surface	24 x 36 ins.
Height of table	18 ins.
Transverse movement of table	6 ins.
Longitudinal movement of table	12 ins.
Distance between housings	3 ft.
Minimum revolutions of driving pulley to one rev. of spindle	6.6 revs.
Maximum revolutions of driving pulley to one rev. of spindle	66 revs.
Distance from floor to highest point of machine	14 ft.
Floor space required	6 ft. x 5 ft.
Weight, net	18,300 lbs.

What is said to be the most dangerous railway in the world is that recently completed up the side of Mount Vesuvius for the benefit of the many tourists that annually visit this famous volcano. It is a cable railway of the mono-rail type, the one car comprising the active rolling stock being supported by two wheels, one at each end of the car. The center of gravity of the car is below the top of the supporting rail, so that it balances without the aid of supporting wheels at the sides. The railway line runs to within nominally 1,000 feet of the crater mouth, but the distance changes from day to day on account of the rapid changes that take place; accretions to the sides of the crater may materially increase the distance one day, and the fall of a huge slice into the seething gulf 500 feet below may considerably lessen the distance the next day. The maintenance of the line in proper alignment is a difficult matter. Fissures opening, the flow of lava, falling cinders, and sliding of the roadbed require constant watchfulness and labor by gangs of laborers who constantly patrol it during the periods of operation. The "train" has no fixed time-table, the trips depending on the activity of the volcano and direction of the wind; some days they are entirely abandoned.—*Railway Machinery.*

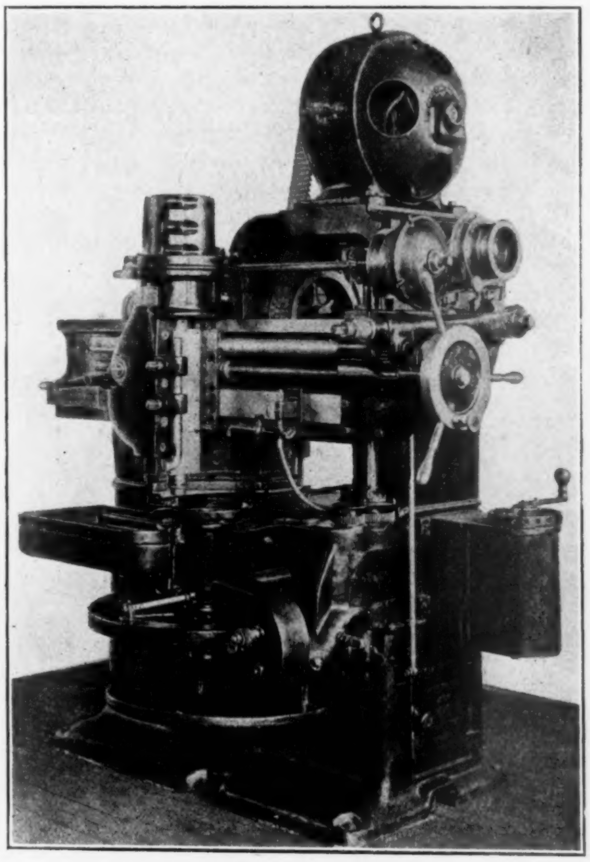
A GEAR SHAPER WITH AN INDIVIDUAL MOTOR DRIVE.

In the few years that the Fellows gear shaper has been before the public it has achieved widespread recognition for its merits as evidenced most convincingly by the large number now in use. To-day nearly all shops that engage in gear cutting to any extent, have one or more of these machines and it is thus hardly necessary to enter here into a description of its details; for that the reader is referred to the builders, the Fellows Gear Shaper Company, Springfield, Vt., for information relative to the construction and operation of the machine. However, it may be briefly stated that the gear shaper differs from the other forms of gear-cutting machinery in that it replaces the rotating milling cutter usually employed by a reciprocating tool having the form of a spur gear. This planes the teeth and at the same time is caused to revolve with the blank intermeshing precisely as its finished mate is intended to. In degree of accuracy this scheme compares with the hobbing method of forming worm wheels, and also corresponds very closely to the latter in principle. The cutters for both may be produced with extreme precision, especially for involute gearing, the only type now in common use, as both then depend on generation by straight lines. For instance, a hob is cut as a perfect V thread, and the Fellows cutter is finished by being caused to roll against the carefully trued face of an emery

wheel with a motion simulating that of a pinion tooth against a rack tooth.

It is the present desire to call particular attention to the machine as now provided with an individual motor drive. The only special work necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these changes a standard form has been evolved as shown in the accompanying illustration.

A 5-horse power Crocker-Wheeler semi-inclosed motor supplies the power, transmitting it with a reduction in speed through a Renold silent chain to the spindle which usually carries the cone-pulley. The speed is further reduced through either of the two regular gear combinations which may be used alternately, making two speeds possible mechanically. In addition, the motor is supplied with current on the Crocker-Wheeler four-wire multiple voltage system giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range, within which, through the faster gear combination it drives the ram at from 94 to 45 strokes per minute, or with the slower gear combination, 43 to 20 strokes per minute. The lower eight available motor speeds may be used to extend the range down to six strokes per minute, though 20 is the minimum in ordinary practice.



A NOVEL ARRANGEMENT OF INDIVIDUAL MOTOR-DRIVING FOR A FELLOWS GEAR SHAPER.

The machine is capable of cutting external gears up to 36 ins. in pitch diameter by 5 ins. face and internal gears 28 ins. in pitch diameter by 3 ins. face, allowing any diametral pitch up to four.

A SERVICEABLE DESIGN OF UNIVERSAL SAW BENCH.

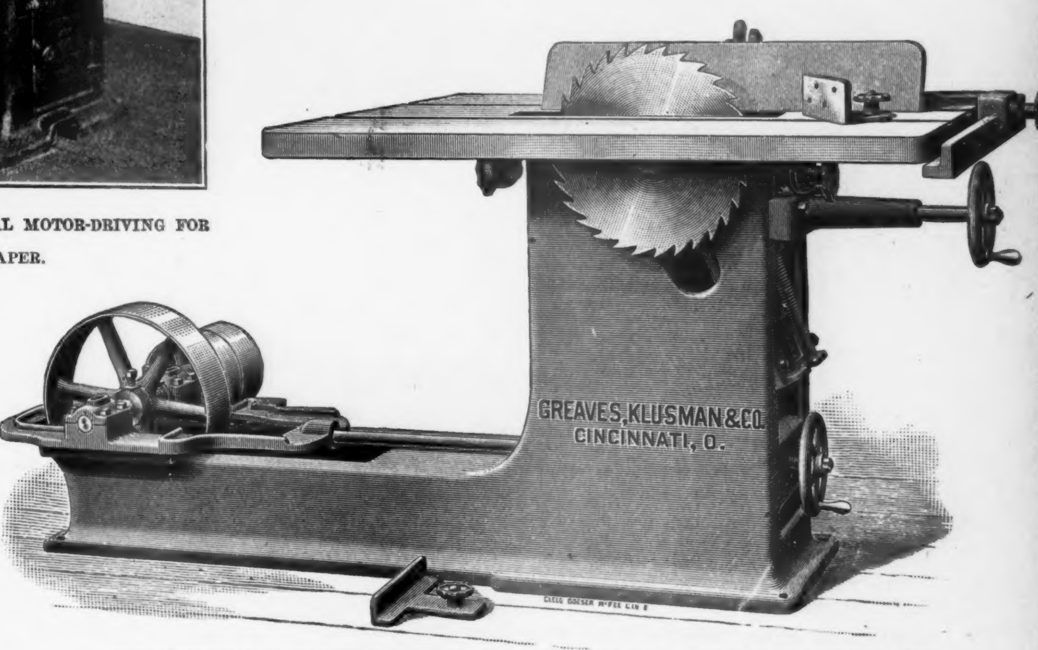
WITH TILTING TABLE.

GREAVES, KLUSMAN & COMPANY.

The accompanying engraving illustrates a particularly valuable design of universal saw bench, with tilting table, which will be found a most desirable and useful tool for any woodworking establishment. It has several special advantages as follows: The great variety and the accuracy of the work it will do; the ease and quickness with which it can be changed from one class of work to another, and particularly the length of the belt, which is longer than on any other machine of this class that we know of.

An important feature of the design of this tool is that the frame proper and the extension carrying the countershaft are cast in one piece, which greatly simplifies the machine and also keeps the countershaft and saw mandrel always in line with each other; the distance from countershaft to mandrel is thus such that all belt slipping is avoided, even when doing very heavy work. By means of the improved belt tightener, any slack can be instantly taken up by simply turning the lower hand-wheel, which is shown at the front of the machine.

The table is of iron, 38 x 48 ins., ribbed and braced and planed perfectly true. The whole table tilts for bevel sawing, and it can be clamped firmly at any angle up to 45 degrees. The opening in the table, which is 4¼ ins. wide and 21¼ ins. long, is filled in with a wooden piece, so that more than one saw, or any style of cutter head, up to 3½ ins. wide, can be used. The mandrel, together with pulley in the center between boxes, is accurately balanced and the bearings are long and lined with the best babbitt. The mandrel is 1¼ in. in diameter between the collars and is raised and lowered by the hand-wheel conveniently placed just below and in front of the table.



THE UNIVERSAL SAW BENCH, WITH TILTING IRON TABLE. — GREAVES, KLUSMAN & CO.

The ripping gauge is thoroughly adjustable, and can be set at any angle up to 45 deg. This gauge can be set on either side of the saw, the table being provided with slotted ways on both sides, for ripping stock up to 16 ins. wide on the left of the saw and 20 ins. wide on the right side of the saw.

The countershaft is placed on a movable frame which is dove-tailed into the main frame, as shown, for longitudinal movement, and adjusted by the lower hand-wheel shown in front of the machine. This makes a most convenient and easily maintained arrangement of driving.

The extended experience of Greaves, Klusman & Company

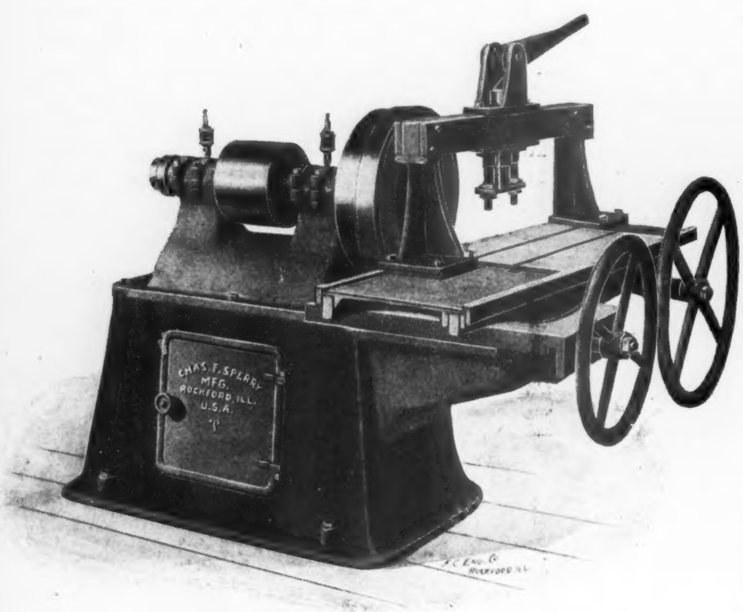
in the manufacture of iron-working tools has placed them in an enviable position to make the most valuable applications of the laws governing machine tool design to the various types of woodworking machinery, which they build. One of the most noticeable features of this machine is its rigidity—this together with its simplicity and compactness make it a most desirable tool. The application of these sensible principles to the design of woodworking machinery appears to be a step in the right direction, and will render them invaluable to users who desire the maximum output and freedom from repairs.

AN IMPROVED CYLINDER EMERY-WHEEL FACE GRINDER.

WITH HAND AND AUTOMATIC FEED AND TRAVEL.

The accompanying engraving presents a comprehensive illustration of the improved cylinder face grinder, designed for either flat or concave face grinding, which is built by Chas. F. Spery, Rockford, Ill. This tool is a very substantial and well built machine and is adapted to the heaviest grinding where absolute rigidity is a requirement.

This tool will handle work 30 ins. long and 6 ins. wide, and is adapted for grinding surfaces on steel or iron, whether soft or hardened. The table has three tee slots to facilitate fastening jigs, for the rapid setting and clamping of dupli-



THE SPERY CYLINDER EMERY-WHEEL FACE GRINDER.

cate pieces of work. As shown in the engraving, the tool is equipped for grinding small castings of a special shape, being provided with a special clamp operated by an adjustable toggle lever so that the work may be clamped absolutely rigid and with the utmost rapidity.

The grinding wheels used upon the Spery grinder are of the cylindrical type, the range of sizes being from 12 to 20 inches, so that all classes of work may be accommodated. The chuck is of cast steel, of a special design and with a screw flange to set the wheel out when worn down even with its face. The arbor is of hardened steel, 2 7-16 ins. in diameter and runs in journals of extra length. A phosphor-bronze end thrust bearing is provided at the outer bearing to take care of the thrust imposed by the grinding operations

The table is provided with adjustments in either direction, the hand wheels for the same being shown at the front of the machine. The adjustment is thus universal to permit of concave grinding, but can be easily arranged for flat grinding. In addition to the hand adjustment an automatic feed is provided for both motions of the carriage. The rigidity made possible by the design of this tool may be estimated from the fact that its total weight complete is 2,800 lbs.

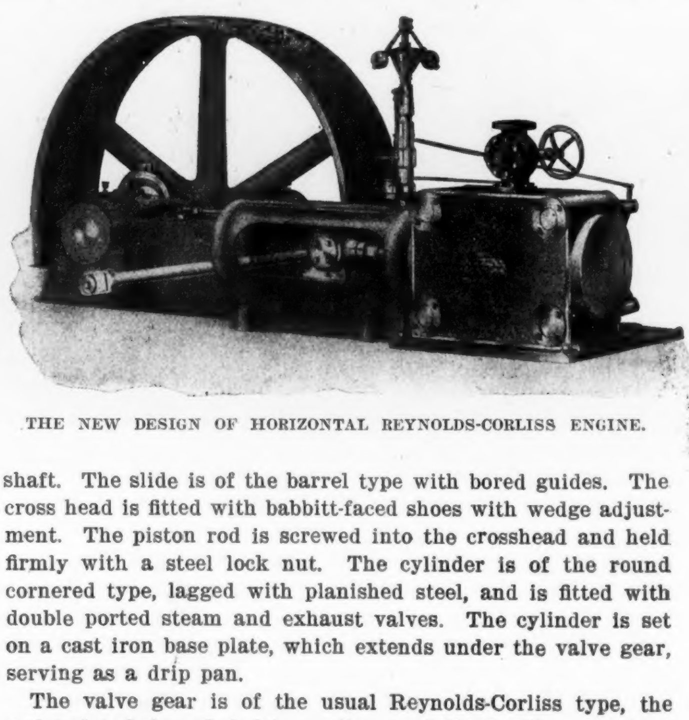
NEW STANDARD REYNOLDS-CORLISS ENGINE.

ALLIS-CHALMERS COMPANY.

In the accompanying engraving we illustrate a new type of Corliss engine which is being brought out by the Allis-Chalmers Company from the designs of Mr. Irving H. Reynolds. The field of the Corliss engine design has been so fully worked over in the past, and the accepted designs have become so simple, that no strikingly novel designs are to be expected; this new engine, however, represents the experience of twenty-six years in building of Corliss engines, and combines all of the more desirable elements of the best designs.

Engines of the type illustrated are being built in seven sizes, ranging from 50 to 500 horse-power, and are designed for steam pressures up to 150 lbs. A novelty is introduced in that they are built of somewhat shorter strokes than have heretofore been customary in Corliss engines, with the idea of economizing in space and making the construction more rigid. The speeds are also somewhat higher than usual, ranging from 110 to 150 revolutions per minute, although these speeds are not higher than those at which the Reynolds-Corliss engines of older design are frequently operated.

The frame is cast in one piece with the slide, the construction being of the box type, resting on the foundation for its entire length. The main bearing shells are bored into the frame, thus insuring a solid bearing and also permitting the easy removal of the shells by rolling them out around the



THE NEW DESIGN OF HORIZONTAL REYNOLDS-CORLISS ENGINE.

shaft. The slide is of the barrel type with bored guides. The cross head is fitted with babbitt-faced shoes with wedge adjustment. The piston rod is screwed into the crosshead and held firmly with a steel lock nut. The cylinder is of the round cornered type, lagged with planished steel, and is fitted with double ported steam and exhaust valves. The cylinder is set on a cast iron base plate, which extends under the valve gear, serving as a drip pan.

The valve gear is of the usual Reynolds-Corliss type, the wrist plate being of skeleton pattern and fitted with a new type of disconnecting device which, while clamping the hook rod firmly, is very easily detached by hand. The dash pots are of a differential plunger type without leathers or packing of any kind. The regulator is of the high-speed weighted type, designed to control the engine within narrow limits of speed variation.

The connecting rod is of steel with solid forged ends, and is fitted with bronze boxes, adjustable by means of screw actuated wedges. The box on the crank pin end is babbit-lined. The crank is of a plain type, polished on the face, and is protected by a planished steel oil guard, which, however, is not shown in position in this view. The crank and crosshead pins and main journals are of the liberal size ordinarily used with the heavy duty Reynolds-Corliss engines.

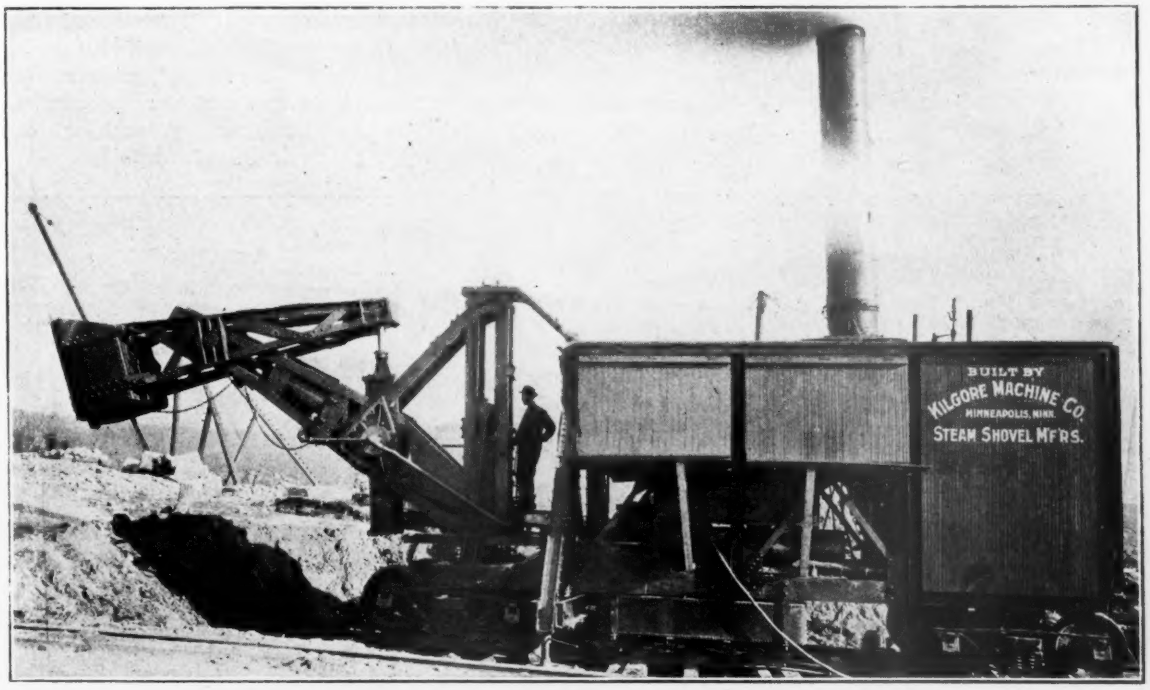
In brief, the engine is strong, simple and compact, and while nothing has been added for ornamentation, nothing contributing to economy or durability has been omitted, and the machine should find a large sale among power users who appreciate quality.

THE KILGORE DIRECT-ACTING STEAM SHOVEL.

The new Kilgore direct-acting steam shovel, herewith illustrated, possesses some features that are distinctly in advance of the practice for machines of this character. The record made by this type of machine is now attracting considerable attention to its way of doing business, which is peculiarly its own.

These shovels are direct acting, all movements of the dipper are controlled by four powerful steam cylinders, operated by steam used for one motion of the dipper is that to fill each cylinder once only. All motions of the dipper can be reversed instantly and with equal power.

This shovel is self-propelling, and can be taken to and operated in places where it is impossible to use large shovels. It has all means within itself to accomplish results that are usually obtained by extraneous aids. If the front trucks are derailed, the dipper can be lowered to the ground, and by using the lifting and swinging cylinders, the front end of the car can be easily and quickly raised and swung on the track.



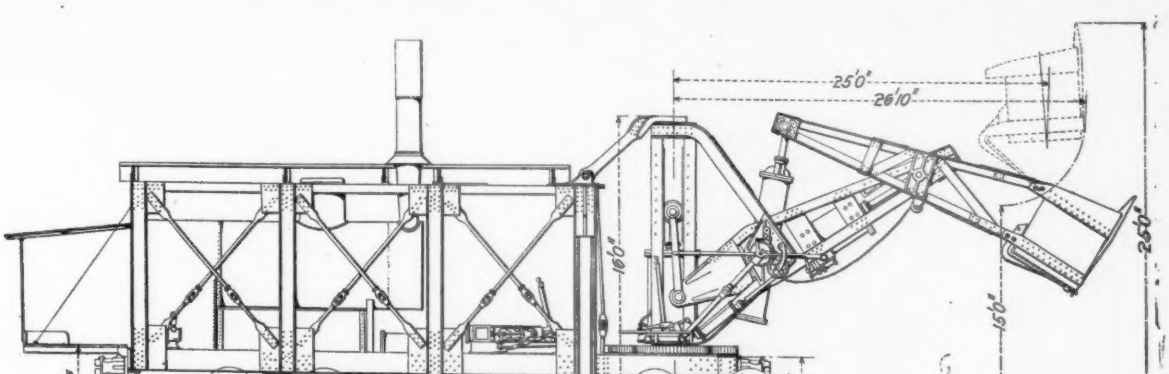
GENERAL VIEW OF THE NEW KILGORE DIRECT-ACTING RAILROAD STEAM SHOVEL.

only two levers, which gives a range of action not possessed by any other shovel, responding to every move of the levers and always in the direction of the motion of the hand.

A distinct advance in the operative construction of these machines is in the absence of all chains, chain sheaves, winding drums, friction clutches, gears or cables. All small details seen on other machines of the kind are eliminated, and all the machinery is direct connected and direct acting. In fact, this machine stands alone in the application of first principles of mechanics to rapid and effective work in its field.

The construction is almost entirely of steel, and therefore up-to-date from the designers' standpoint. The steam consumption is low, since the steam is used expansively and in accordance with the amount of work done, the point of cutoff always being under control of the operator. The maximum amount of

The dipper is arranged to be moved forward or back by means of the forcing cylinder, thus giving a chance to withdraw the dipper from the bank when full, and dump without going clear through to top of the bank. This movement may also be used to spot cars when dumping. The dipper may be shaken violently to toss off sod or any large objects too large to pass through dipper opening. By working the two pistons at once, the dipper can be moved in a direct line to any point desired, it will also dig in any material, or nose around a root or rock. These features are a recounting of only a few of the favorable things that may be said about the machine, which is set up to conform to standard railroad clearances and can be used in any place where rails are laid. The capacity of the shovel is from $1\frac{1}{4}$ to $2\frac{1}{2}$ yards. This machine is built by the Kilgore Machine Company, Minneapolis, Minn.



DETAILS OF THE $2\frac{1}{2}$-YARD KILGORE DIRECT-ACTING SHOVEL.

ACME GAS, A NEW FUEL.

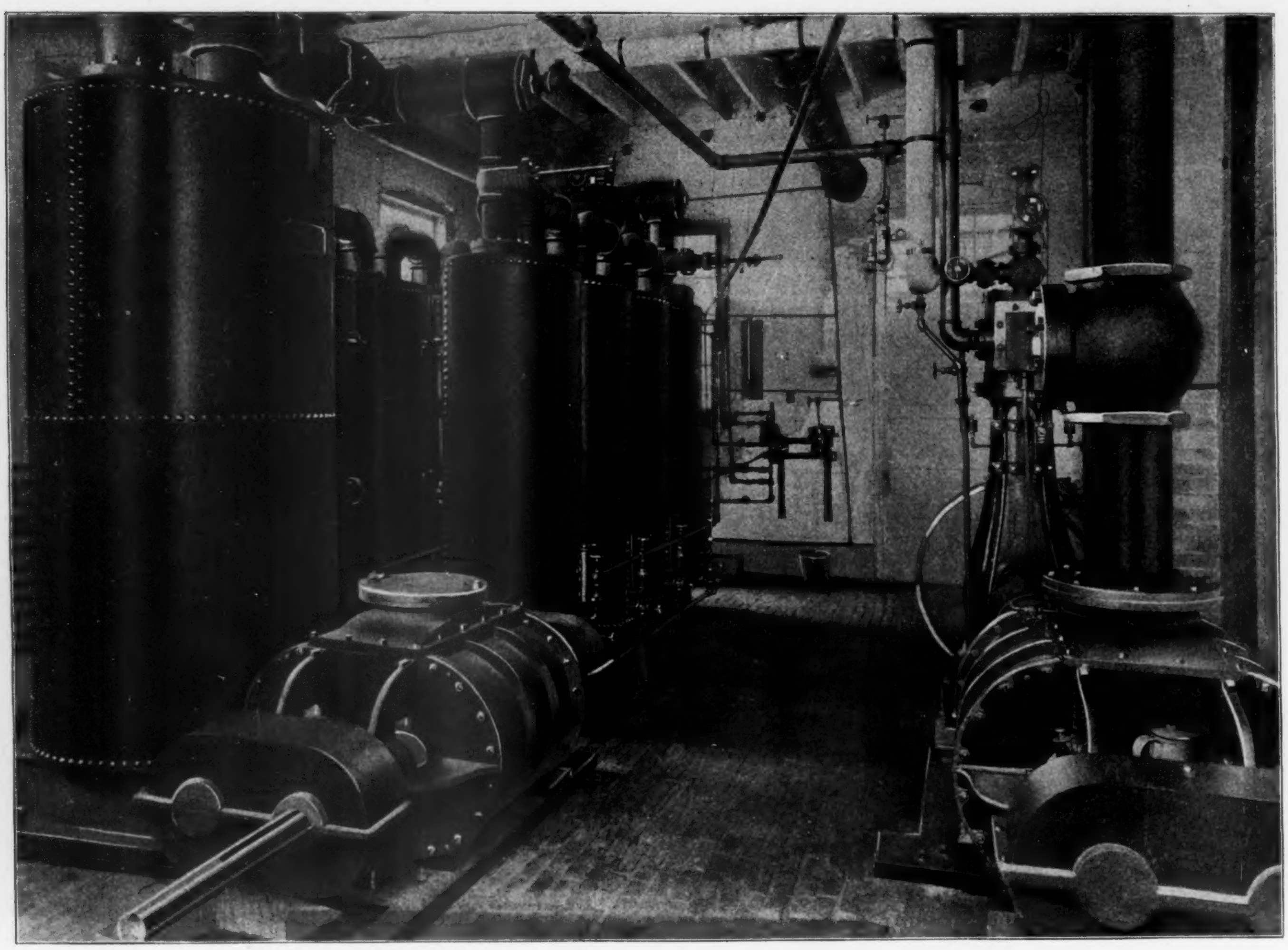
FOR FORGING AND HEATING PURPOSES IN RAILROAD SHOPS.

The most modern development in the engineering world in the direction of fuel application to furnaces for the heating of iron and steel for forging purposes and general furnace work, is in the conversion of crude fuels into gas. Fuel experts have always agreed that gas is the most efficient as well as the ideal fuel, both because in gasifying crude materials a far greater percentage of the heat units are made available, and because fuel when gasified is converted into a form which can be applied to furnaces to the greatest advantage, and the most perfectly controlled.

The problem before the engineering world has been to develop a system with which gas could be manufactured at a sufficiently low cost to make its use as fuel in furnaces practicable and economical, and to discover a process of generation which would produce gas from an apparatus of simple and compact enough construction to enable the individual manufacturer and railroad shop to install a gas plant inside their own premises. The advent on the market of Acme gas and Acme gas plants, which are manufactured by the Acme Gas Company, Monadnock Building, Chicago, has offered a solution to these problems which is altogether feasible and extremely simple.

Acme gas is made from crude distillate of petroleum at a cost of from 8 to 12 cents per thousand cubic feet. It is a gas of high calorific efficiency, and more similar in character to natural gas than any other product. It is made by forcing air under pressure through crude distillate of petroleum. No heat or retorts are required in its generation and it is entirely free from impurities. The plant is of simple construction, automatic in its action, requiring but little attention and only a small amount of floor space. The plant is so constructed that it manufactures gas as fast as required and no faster, so that no gasometer or holder is required. Another point that adds greatly to the efficiency of Acme gas is that the process of generation is such that any required pressure can be secured from 7 lbs. down to 2 ozs.

Acme gas is particularly adapted to forging and welding, and general furnace work. It has been used to the exclusion of all other fuels in the Government Navy Yard at Washington, D. C., for the past four years, in large ingot furnaces, open blacksmith forges, etc., and since the plant was installed at Washington, this system has been adopted by the Government in the yards at Charleston, Brooklyn, Portsmouth and Mare Island. It is particularly serviceable and economical for annealing, tempering and hardening, galvanizing, crucible work, japanning, brazing, etc. It is now being used by many of the largest manufacturers of tools, railway equipment, implements and machinery of all kinds, in place of coke, coal and fuel oil.



VIEW OF A LARGE ACME-GAS GENERATING PLANT. ACME GAS COMPANY.
Capacity—25,000 cubic feet per hour.

This gas is used as fuel in the car shops of Armour & Company and Swift & Company at Fort Worth, Texas; also by the Buda Foundry and Manufacturing Company, Harvey, Ill., for forging car axles, arch bars, construction work in connection with the manufacture of hand cars, switches, frogs, crossings, etc. The accompanying illustrations show an Acme gas furnace for heating car axles and a large Acme gas plant.

The economy of Acme gas above the use of coke and coal is very great, not only on account of the cheapness of the gas as fuel, but on account of largely increased output over coal and coke furnaces and forges. The increase in output ranges from 50 to 300 per cent. and is brought about by the fact that the fire in Acme furnaces and forges is continuous and perfectly uniform, that the men's time is wholly given to their work and

VIEW OF AN ACME GAS FURNACE SPECIALLY DESIGNED FOR HEATING CAR AXLES.
(In this furnace two 6-inch axles are brought to a dripping heat in 20 minutes.)

not to tending their fires, that the delays of building and rebuilding coal and coke fires are entirely eliminated, and that the degree of heat can be absolutely regulated by simply turning on more or less gas.

Other advantages not possible with the use of coal are, the absence of the fire box; the freedom from the expense of the firemen; the freedom from the annoyance and cost of removing ashes. Gas is also desirable because of its cleanness, there being, with its use, an entire absence of smoke, fumes and the unsightly hoods and uptake pipes, so common in shops in which coal is used as fuel.

Acme gas furnaces are very much smaller than those necessary for coke and coal, or even fuel oil furnaces, and consequently a great saving of floor space is secured. They are ready for work ten minutes after they are lighted. When they are not being used, the gas is turned off and there is no waste. They are constructed with a slot opening, to enable a number of pieces to be put in at once. When one piece is taken out to be forged or bent, a cold piece is put in in its place, so that there is no waiting for heats.

The method of producing Acme gas is by forcing air under pressure through a series of generators containing crude distillate of petroleum. The oil which is stored in an underground tank is admitted into the generators by means of a pump which delivers the oil as fast as it is being used. The air supply is furnished by either a rotary positive blower or an air compressor. Thus this gas consists entirely of a combination of air and oil; the two being so admixed as to form a fixed gas, of great heating power, in character very similar to natural gas. The crude distillate of petroleum from which the gas is made, having been run through a still, all impurities are removed from it, as well as the heavier portion of the petroleum, so that the gas contains no sulphur or other substances which have a destructive effect upon metals. Because of its purity Acme gas forms less scale in heating iron and steel than other fuels. This fact, together with the intensity of the heat and its peculiar soaking quality, makes the gas particularly adapted to perfect welding.

The method of application used in connection with the Acme furnaces makes it possible to obtain either a long, yellow flame or a short blue, intense Bunsen flame, as an air blast under the same pressure as the gas, is piped to each furnace, and the air and gas pipes are brought together at the burner with a valve on each. The character of the gas is such that no special burners are required, it being usually burned from an open pipe. The Acme gas producing plants are so simple in their operation as to require very little attention. In order to start the plant producing gas, it is only necessary to start the blower and oil pump. After that only casual attention is required, until night, when the blower and pump are stopped and the oil drained back from the generators into the storage tank.

BOOKS AND PAMPHLETS.

Machine Design. Part I. Fastenings. By William Ledyard Cathcart, Adjunct Professor of Mechanical Engineering, Columbia University; Member American Society Mechanical Engineers, American Society Naval Engineers and of Society of Naval Architects and Marine Engineers. 290 8vo pages. Illustrated. Published by D. Van Nostrand Company, 23 Murray Street, New York. Price, $3.00.

This work is of particular interest as being a most comprehensive treatise on the subject of machine design, covering the ground so thoroughly as to be comparable with the famous English work by Unwin. This new book by Prof. Cathcart should receive most favorable notice and, although not a pioneer in its field, is none the less interesting, and is of great value, since it is only the beginning of what will eventually be a most extended and complete treatment of the subject. The thoroughness with which Prof. Cathcart has gone into the matter is evident from the fact that this whole volume is devoted entirely to machine fastenings. The first chapter presents a most careful and satsifactory treatment of shrinkage and pressure joints. The treatment is theoretical, and many tables are given. Following this come screw fastenings, riveted joints, keyed and pin joints. Throughout the work there are theoretical mathematical discussions and tabulated sizes, for convenient reference. The book abounds in tables, not only of dimensions, but of strength of materials, the properties of matter, etc. Considerable attention is given to U. S. Government specifications for screws, riveted joints, etc. To illustrate what is done in the way of theory, may be mentioned the stresses in screws, torsion due to thread friction, stresses in nuts, efficiency of the screw. Altogether the volume is to be recommended as an advanced and practical reference work on such parts of machine design as its pages treat. The printing and illustrations in the work are excellent. The later volumes of this very promising series will be anxiously awaited.

Locomotive Breakdowns. Emergencies and Their Remedies. By George L. Fowler, M. E. Published by Norman W. Henley Publishing Company, 132 Nassau Street, New York. 1903.

This is a catechism treating of accidents and breakdowns of locomotives on the road and gives instructions for emergency repairs. It is the most complete work devoted to this subject and is a book which will be valuable to those who have to deal with the operation of locomotives. It is evidently intended for locomotive engineers and firemen and is admirably adapted to their needs.

The Gas Engine. A treatise on the Internal-Combustion Engine. By F. R. Hutton, Professor of Mechanical Engineering, Columbia University. 483 8vo pages. Illustrated, 243 figures. Published by John Wiley & Sons, New York. Price, $5.00.

Up to the time of the appearance of this volume there has been no comprehensive American treatise on the gas engine, such as have appeared being either of a popular nature or else dealing specifically with gas engine design. The present volume is intended to be a comprehensive American treatment, unsparing in its theoretical deductions, with due consideration of the application of theory to practice—it is of such character as to place the reader in touch with the wonderful gas engine development in this country in the past few years. The most exhaustive chapter, and one which will be appreciated by the investigator, is one on the theoretical analysis of the gas engine. This chapter discusses the different gas engine cycles more complete than any previous work. The volume presents what is latest in connection with the blast furnace and producer gas apparatus. The first three chapters are introductory, reviewing the physical properties of hydrocarbon for power purposes, touching upon the various gases available, for use in an internal combustion engine. Following this is a discussion of a heat engine cycle; chapters on gas, gasoline, kerosene, and alcohol engines; carbureters; methods of ignition; governing, etc. There is a chapter on experiments with explosive mixtures, one on the performance of gas engines by tests, and one on the manipulation of gas engines which considers the ills that such machines are heir to. While many of the chapters are easily read and free from mathematics, the work on the whole is an advanced treatise and one to interest the mechanical engineer or designer.

American Railways, By Edwin A. Pratt, Reprinted with Additions From "The Times" (London). Published by MacMillan & Co., Limited, 66 Fifth Ave., New York, 1903. Price $1.25.

The author of this book spent four months in a study of American Railways, as a special correspondent of *The Times* and presented his observations in a series of thirteen articles in that newspaper. These have been elaborated and extended for permanent record in this book. The author is a close observer and an interesting and impartial writer. While he writes from the standpoint of an experienced traveler, rather than a railroad man, his ideas of the business questions involved in American railways are remarkably clear. His conclusions, like those of others who have studied both English and American railway methods, are that each system is specially well adapted to the conditions under which it developed and that there is little to be gained by introducing the methods of one into the other. This is rather a non-committal statement and it may be challenged. There must be much in each system, which may be profitably considered in the other, else such a book as this would be valueless. One thing which stands out prominently is the author's astonishment at the cheapness with which human life is held in this country. He stands aghast at the way our main lines of well known and prominently advertised railways run through streets of populous cities and he has something to say as to our accident reports. The author is a competent critic, who is evidently very fond of English methods. He does not tear our methods to pieces, but simply says that they will not answer in England. His views may be read with interest by American travelers, and with profit by American railroad officers.

Coal-Washing Machinery.—The Jeffrey Manufacturing Company, Columbus, Ohio, have recently issued an interesting and very comprehensive catalogue in the interests of their improved coal-washing machinery. Many of the prominent plants installed by them for coal-washing are carefully illustrated and described. Plants of their build are to be found in all parts of the country, and they are operating with absolute success. Much interesting data upon this subject is also presented in this book. It should be in the hands of all who are interested.

DIXON'S GRAPHITE SUGGESTIONS.—This is the title of a 24-page illustrated pamphlet devoted to the interests of the Dixon graphite products. It is an excellent piece of catalogue work and gives the impression that graphite is indispensable in many lines of the mechanical arts, particularly for lubrication. Copies may be had from the Joseph Dixon Crucible Company, Jersey City, N. J.

EQUIPMENT AND MANUFACTURING NOTES.

The Crocker-Wheeler Company, Ampere, N. J., has established headquarters at 425 Empire Building, Atlanta, Ga., for the Southern representative of its Washington office, Mr. S. M. Conant.

The Houston, Texas, office of the Walter A. Zelnicker Supply Company of St. Louis, manufacturers and dealers in railway, mill and factory supplies, has been removed to No. 603 Binz Building. Mr. H. E. Miller, who for many years has been in charge of this office, will continue as manager.

We are pleased to learn that the Homestead Valve Manufacturing Company of Pittsburg, Pa., have installed a complete iron foundry, which was started December 7, in conjunction with their well equipped brass foundry. Both brass and iron castings are produced through the use of the improved converting furnaces, in which a heavy blast is used, the process resulting in purer and better metal in every way than crucible or cupola furnaces produce; this enables them to make the superior semi-steel for the valves for which they are so favorably known.

The Diamond Machine Company, Providence, R. I., announce that they have purchased the disc grinder business, good-will, patents, etc., of the George Gorton Machine Company, Racine, Wis., and are now manufacturing the machines at their works in Providence. The Gorton machines have enjoyed, in every respect, the highest reputation. They will be furnished with grooved or flat discs; in all there are 23 varieties of the machines, including those which are electrically driven. A new catalogue is being prepared and the Diamond Company will be pleased to send a copy to anyone desiring one.

Continued activity in trade and recent large orders are reported by the A. Leschen & Sons Rope Company, 920-932 North First street, St. Louis, Mo., for their wire rope and supplies, the aerial wire-rope tramways which they manufacture and erect, and likewise their underground and surface haulage plants. "We Pull for Leschens" is what reads on the large leather collars of the horses attached to the wagons of the A. Leschen & Sons Rope Company in St. Louis, New York, Chicago and Denver. These are the wagons in which they deliver their reels and coils of Hercules and patent flattened strand and all other kinds of wire rope.

The American Steam Gauge and Valve Manufacturing Company have again been compelled to seek new quarters, owing to the increase of their business, and are at present removing their entire plant and offices from Bismarck street, Roxbury district, to the large buildings, 208-220 Camden street, Boston, Mass. The buildings have floor space of 85,000 sq. ft. The Mowry & Phillips foundry department will also be removed from South Boston and every branch of the business consolidated at the Camden street factory. The new plant will afford them more than double the present capacity, and will be employed in producing their valves, gauges and indicators; also special metals and foundry work in the Mowry & Phillips department.

The Michigan Lubricator Company, Detroit, Mich., have recently brought out an important improvement in their well known locomotive sight-feed lubricators, in the form of an automatic safety device over the sight-feed glasses, which has been thoroughly tried and tested, and has been found absolutely effective. This improvement prevents injury to engineers and firemen in charge of locomotives, from the escape of steam and oil caused by the blowing out of sight-feed glasses. Check balls are used in the top sight-feed arms, and in the water tube, and by the use of a valve and check ball in the top arm, any broken sight-feed glass can be renewed without shutting off the other sight-feeds, or other connections, or the throttle, and this may be done while the balance of the sight-feeds are in operation. The check ball in the water tube also prevents the syphoning of oil or water out of the reservoir of the lubricator at all times.